4.6.1.1 *Site Preparation.* Much preparation would be needed before retrieval begins. This would include establishing contamination control zones and construction lay-down areas, constructing perimeter fencing, obtaining utilities, installing monitoring devices, and constructing access roads. Three additional tasks required for site preparation include characterizing existing soil cover, constructing support structures, and removing clean overburden soil.

4.6.1.1.1 *Soil Cover Characterization*—Characterization would be performed with probing techniques similar to those recently used at the INEEL during the OU 7-10 Stage I Project and would be used to determine soil cover (overburden soil) thickness and general chemical and radiological concentrations and properties. The data would be used to determine the amount of clean soil that could be initially stripped and stockpiled onsite before containment construction. Stockpiled soil would be reused as clean backfill in the retrieval areas. Probes would be installed in the soil cover and radiological concentrations and cover thickness determined. Soil samples also would be collected from the casing or by hand auger or geoprobe methods for subsequent laboratory analyses.

4.6.1.1.2 *Construction of Retrieval Support System*—Constructing support buildings for the retrieval would be the next preparatory step. Proposed buildings would contain treatment facilities, lag storage, administrative space, a decontamination area, and an equipment maintenance and storage area. General locations of these facilities are shown on Figure 4-18. The AOC would be established for the project to encompass all areas associated with the retrieval action.

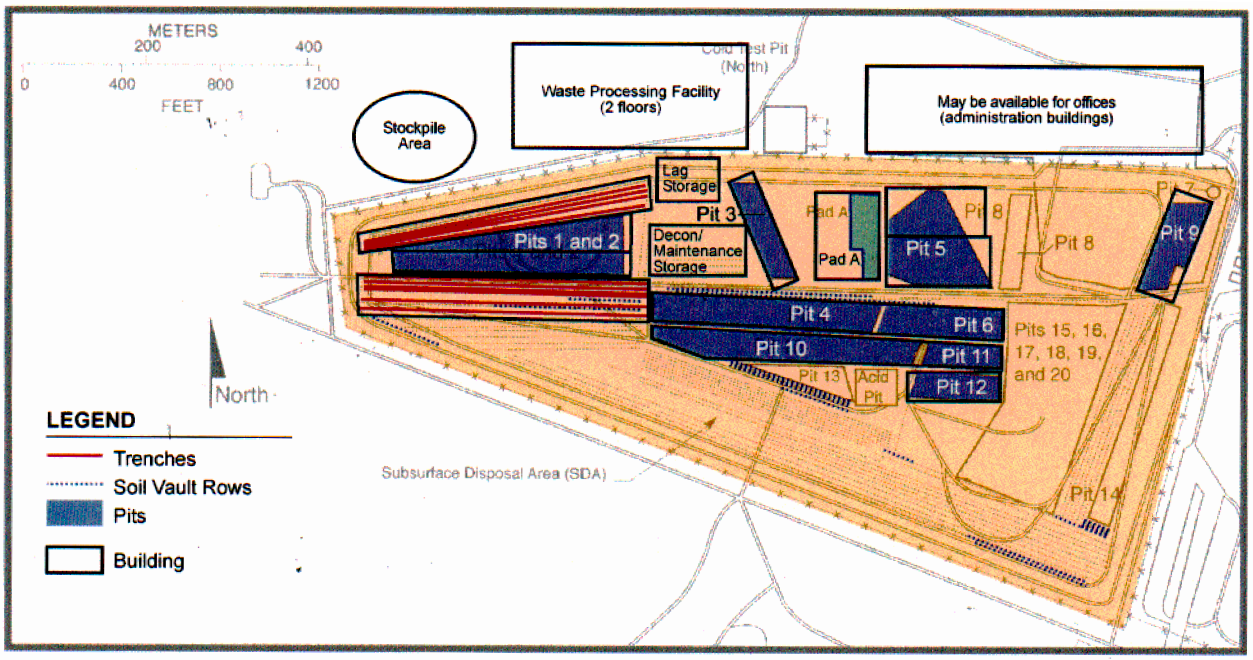

Figure 4-18. Layout graphic for the retrieval action site.

All buildings would be designed and constructed in accordance with the International Building Code and Performance Category 2 standards for wind, seismic, and flood design requirements. Heating, lighting, and ventilation systems are required for all structures. Additional design details would include the following:

- Administrative buildings that would contain personnel required for project management, engineering, project controls, and other management and administrative activities. The 10,000-ft^2

administrative building area(s) would provide office space, meeting rooms, shift worker lockers with change rooms and showers, radiological control offices, and lunch rooms.

- Equipment maintenance and storage buildings that would provide approximately 10,000 ft^2 of space to house necessary equipment such as fire trucks, forklifts, trucks, spare waste bins, PPE, and other necessary equipment and supplies. The building would have separate space for performing maintenance on various pieces of equipment required for retrieval, transport, and treatment activities.

- Decontamination building that would be used for equipment decontamination. The 5,000-ft^2 building would contain several separate decontamination areas and two large doors to allow moving equipment into the building.

- Lag storage building that would be used to initially separate TRU and non-TRU waste and soil and provide temporary storage for these materials before shipment to the treatment facility. The 70,000-ft^2 building has been sized for operation of nondestructive assay (NDA) equipment along with sufficient space to store 16 weeks of retrieved waste and soil. The structure would have a reinforced concrete floor with a ceiling height of 15 ft and two large doors to accommodate waste entry and exit. Materials would be transported within the facility using forklifts.

- Treatment facility that would be separated into TRU and non-TRU processing areas. The building would be a two-story facility, approximately 44 ft high. The facility would be designed as a Category 2 nuclear facility and include pressure process areas, airlocks, multiple contamination control zones, cascading ventilation systems, multiple HEPA filtration on building and process exhaust streams, and continuing monitoring of emissions. Exhaust systems would consist of the following components: quencher, venturi scrubber, packed bed scrubber, demister, reheater, catalytic oxidation, parallel HEPA filters, carbon filters, and parallel off-gas fans. In addition to waste treatment components, the 130,000-ft^2 facility would accommodate remote container-opening and waste-sorting equipment, which would include gloveboxes, large and small manipulators, and sizing equipment.

A secondary storage building would be constructed adjacent to the waste treatment facility to provide storage space for waste shipments before transportation to WIPP. The 75,000-ft^2 structure would be sized to provide approximately 225 days of storage, assuming waste drums would be stacked three high.

4.6.1.1.3 Overburden Soil Removal—Initial excavation activities at the site would involve removing clean overburden soil. Soil would be excavated from proposed retrieval areas in stages with a bulldozer or other excavation equipment. Because the soil is assumed to be clean, this activity could occur in the open atmosphere before constructing containment structures. Clean soil would be stockpiled, further characterized through sample collection and laboratory analysis, and used as backfill. A common stockpile area would be defined (located outside of the AOC if necessary) and used for the duration of the project. Stockpile management would include run-off and wind control. For costing purposes, it is projected that an average of 5 ft of overburden soil could be removed as clean material. Removing this overburden would generally leave a thin layer of soil (1 ft) over the waste matrix; however, a thicker cover might be left over some areas, particularly if high-radiation levels are encountered or radiation exposure reduction is desired.

During design or after the characterization effort, the decision might be made to excavate the overburden inside of containment. In this case, the overburden would be left in place until the time of waste excavation.

4.6.1.2 Primary Technology—Retrieval.

The following sections discuss primary elements required for retrieval actions. These include containment structures and equipment, the process to retrieve buried material, monitoring used at the digface, and waste containerization.

4.6.1.2.1 Containment Structures and Curtain Confinement

A double-walled structure erected over a pit or trench area would serve as primary and secondary containment to isolate the retrieval action and enclose the laydown, decontamination, and equipment storage areas. The identified retrieval process requires that 12 separate containment structures be constructed. The width of each structure would be restricted to 200-ft or less to facilitate designing and operating an internal crane system. Locations of pits and trenches would make it possible for one building to contain more than one pit or trench. Proposed groupings of pits or trenches per building are shown on Figure 4-18. Pits that have a span greater than approximately 200 ft (e.g., Pits 1, 2, and 5) would require using H-piles to construct the perimeter wall within the disposal units. H-piles would be driven into underlying basalt to provide support. The common wall would be shared by both containment structures. As retrieval progresses into the subgrade in these areas, lagging would be placed and sealed between the H-piles to prevent contamination exposure. Assuming that containment structures would be built to Hazard Category 2 safety standards, each structure would be required to meet certain seismic, flood, and wind restrictions. Modular structures could be moved to some extent as retrieval progresses to minimize capital costs during construction.

4.6.1.2.2 Pit Excavation Approach

An operator in the cab of an excavator would retrieve waste from the pits by benching down and then removing it from an at-grade position, as shown on Figure 4-19. A conventional excavator with the above modifications was chosen for this PERA over a remote excavator for various reasons. The hermetically sealed excavator would allow operators better visibility of the digface, which would promote precise digging and sorting and better control of waste. In turn, this precision and control would decrease the amount of equipment breakdowns, significantly increase overall production rates, and help maintain a safer environment. However, developments to remote excavators are improving the reliability and efficiency of such equipment. Therefore, it is expected that an appropriate, cost-effective, remote excavator would be available for use at the time planned for excavation.

As shown in Figure 4-19, contamination control at the digface would consist of a series of moveable flame-retardant plastic or metal curtains (similar to those used in the INEEL TSA to protect against leaking boxes). These curtains would provide for contamination control and confinement and would be sealed as well as possible, but are not expected to serve as containment. A gantry crane would be used not only to hold and move curtains within the containment structure, but also would be equipped to apply water, foams, foggers and support lifters, detectors, metal curtains, and other equipment. The curtain confinement also would incorporate a ventilation system. The system would apply negative pressure to the digface and direct the airflow to HEPA filters and a thermal treatment system to control contamination and prevent it from entering the large primary and secondary containment structure.

A system to apply a water vapor mist to fully saturate air exhausted from the retrieval zone would be constructed to control airborne contamination. A recycle system also would be constructed for condensate collected in the system before treating the air exhaust. Air treatment would employ a thermal oxidation unit, acid scrubber, demisters, heaters, and banks of HEPA filters in two parallel systems to provide redundancy in the event one system failed. The combination of the thermal oxidation unit and the acid scrubber would effectively treat any organic compounds that might be encountered during excavation. Remaining elements of the treatment system would be used to keep all other particulate matter from exiting the curtain confinement.

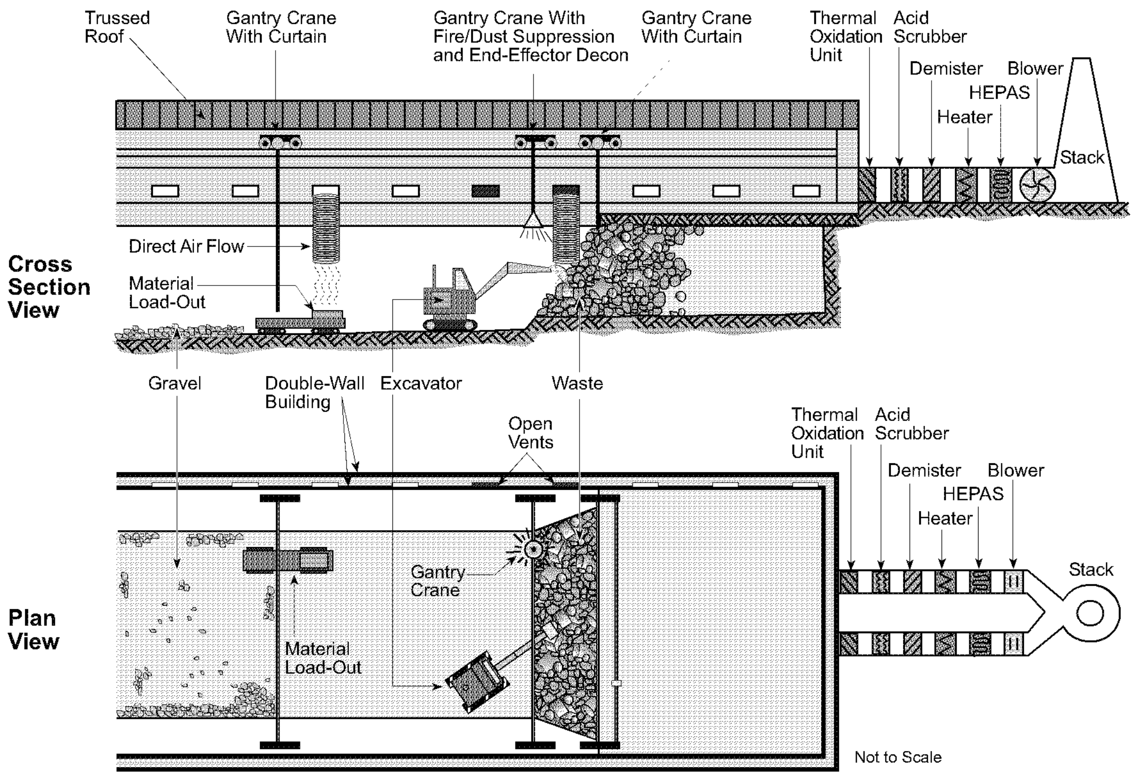

Figure 4-19. Excavation concept for pits.

An air lock system, similar to those used in nuclear facilities, would be used to facilitate moving drums and waste, each in bins, out of the curtain confinement. An airlock system with water, misters, foggers, venting, and other means of control also would provide entry and protection for personnel.

The at-grade position shown in Figure 4-19 offers more advantages than an abovegrade position. Working from an at-grade position provides better visibility of the work area. This would further increase production rates and offer operators more time to plan the retrieval, thus increasing production rates (Valentich 1993). In addition, handling large objects from an at-grade position decreases the risk of the pit collapsing or the excavator overturning, and personnel can access waste as necessary to collect samples for nonroutine circumstances. To further decrease risk of a pit collapsing, sidewalls of the excavation would be sloped in accordance with OSHA regulations, or sheet piles would be used to meet safety standards.

A modified, manually operated excavator would retrieve buried waste and soil. Modifications would include a hermetically sealed cabin (sealed and positive pressure) equipped with a complete supplied-air system that would circulate air to the cabin and the engine compartment. Shielding would be required on the equipment to protect workers from radiation. In addition, the excavator would have air supply tanks attached to the inside of the cabin with an emergency escape pack in the cab. Operators would wear PPE with a facemask and supplied air and move into the cab through a control area that has a clean path to the equipment. Contamination control would be available in the event of an emergency where the operator had to leave the excavator while inside the containment structure. Refueling or maintaining the excavator would be conducted at stations inside the curtain confinement zone specifically designed for these operations.

Proposed safety measures would provide operators with multiple levels of protection. Technologies such as these have proven reliable in various hazardous and contaminated environments.

Personnel-operated heavy equipment with sealed and pressurized cabins modified with either supplied air or filtered air has been used successfully at many sites, including Maralinga and Calvert City. Shielded excavators have been proven at sites like Hanford in the 100N Reactor Area.

As the digface progresses, the excavator would carefully pick at the digface with a small bucket equipped with a thumb for grasping pieces of waste that do not fit into the bucket (or other end-effectors), then the excavator would place waste and potentially clean overburden into soil bags or waste bins (lined with poly-sacks). Metal curtains held by the gantry crane would be moved in approximately 30-ft increments as the digface progresses to provide continuous contamination control. Overhead support systems also would be advanced with the retrieval equipment. In addition, the walls and ceiling would be painted and sidewalls fogged and sprayed with a fixative as curtains are moved to ensure contamination is fixed in place. This type of operation has been demonstrated and is proven in nuclear applications (Sykes 2002). Fire-suppression systems, water misters, painting and fixative systems, and other contamination control devices (e.g., fogging system) would be hung from a gantry crane for use inside the curtain confinement zone.

As waste is removed, operators would attempt to keep contents of each bin as homogeneous as practical (presorting), while simultaneously trying to minimize actions that might contaminate clean soil surrounding the waste zone. For example, operators would try to keep metals in one bin and potentially clean overburden, sideburden, and underburden (1 ft between cleanburden and waste) in another bin. In addition, various end-effectors and precise digging and extracting would maximize the amount of segregation that could be achieved at the digface and within the curtain confinement zone. This process would simplify segregation required at the waste processing facility and facilitate waste processing in campaigns based on selected waste types. Waste that would require cutting or sizing to fit in the bins would be temporarily set aside for handling by another piece of equipment. This technique was found useful at Hanford (Sykes 2002) and may increase production rates. Intact drums and containers would be extracted using appropriate end-effectors available to the excavator in the curtain confinement zone.

Some items would not be treatable with the selected sizer or cutter located in the storage area (as would be the case for large tanks, trucks, reactor vessels, and heavy machinery). Those items would be removed from the digface and relocated to a nearby, out-of-the-way location until the appropriate disposition could be identified. High-level waste, Class C waste, or other materials not amenable to treatment or onsite disposal would be temporarily left in place until appropriate disposition was determined.

4.6.1.2.3 Trench Excavation Approach—The excavation approach for trenches would be similar to that described for pits, as illustrated in Figure 4-20. Containment structures, curtain confinements, and supporting equipment would be the same as described for the pits. However, because several trenches are aligned approximately 8 ft from each other, containment structures could be built over multiple trenches and worked as one waste site. Excavation would systematically remove waste, but leave clean soil between trenches. The waste face would be advanced approximately 15 ft, and then clean soil between trenches would be removed and used as backfill in the excavated area behind the equipment. Because waste containers in trenches are likely more intact than in pits, various end-effectors would be available to remove material from the digface in a precise manner and keep containers intact. Properly using end-effectors would mean carefully extracting intact containers for direct placement into bins.

4.6.1.2.4 Pad A Excavation Approach—The Pad A excavation would employ a slightly different approach than that used for pits and trenches, because the area is aboveground with relatively intact drums and deteriorated boxes. As shown in Figure 4-21, the entire excavation area would be enclosed in a double containment building.

The building would incorporate similar contamination control measures and a similar filtration system to the ones used for the pits and trenches. However, the Pad A containment structure would be much larger than the structures used for the pit and trench excavations to accommodate the abovegrade location of the Pad A waste and impacted soil. Records indicate that Pad A contains only a minor amount of TRU material and therefore would not require the same protective measures needed in the pits and trenches. Conversely, other radiological contaminants must be considered in the Pad A retrieval design. Equipment would include standard excavation equipment (e.g., a backhoe and front-end loader). In addition, it is projected that curtains would not be used to isolate the digface within the secondary containment structure.

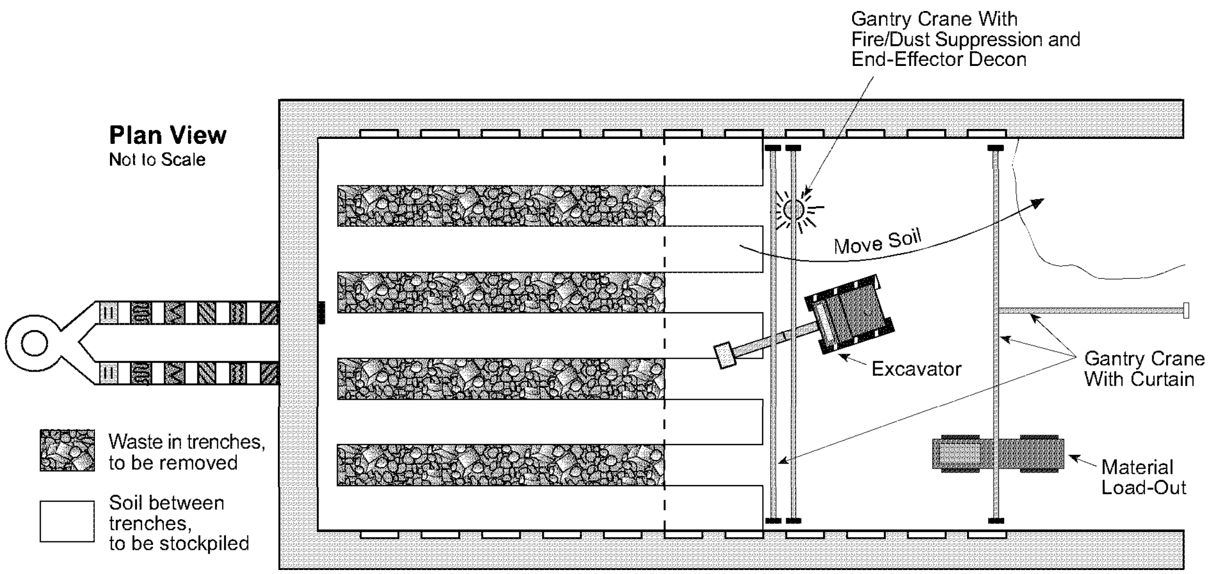

Figure 4-20. Excavation concept for trenches.

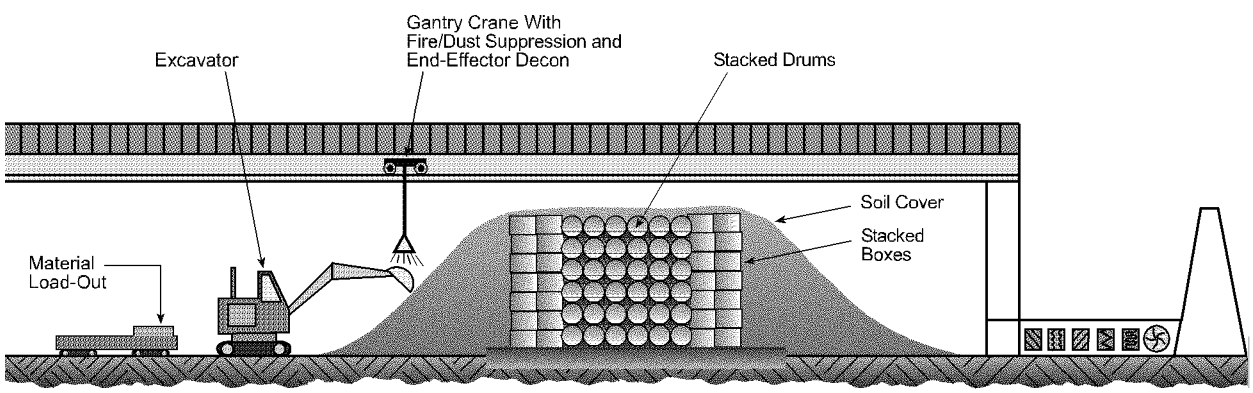

Figure 4-21. Excavation concept for Pad A.

4.6.1.2.5 Production Rates—Retrieval actions could be designed to maintain a production rate of 76 m^3 (100 yd^3) per day. This projected production rate was based on evaluating retrieval equipment, cold tests, previous SDA retrievals, retrieval actions in the United States and Australia, treatment throughputs, storage capacity, and disposal facility rates of waste acceptance. Retrieval operations would be conducted 200 working days a year for this alternative, and crews would work four 10-hour shifts each week. Various factors could impact this production rate. Factors that would decrease production include the availability of only one piece of equipment for digging, sizing, and sorting material and the occurrence of unexpected conditions (e.g., unknown materials, equipment breakdown, and poor weather) (Sykes 2002). Factors that would increase production include using larger bucket sizes, the ready availability of end-effectors for changing operations, operating more than one retrieval operation in parallel, and the availability of a second piece of equipment for sizing and sorting (Sykes 2002).

4.6.1.2.6 Monitoring at the Dig Face—Monitoring at the digface would include gamma-radiation, health and safety, criticality, simple chemical testing to identify reactive and ignitable materials, and visual monitoring to determine digging strategies and to protect workers and the environment. Prior characterization results, available shipping records, and being observant during excavation should result in safe and productive retrieval. Therefore, the only characterization that would be performed at the digface would be for protection from gamma radiation and VOCs and simple chemical screening. This would require a gamma detector and VOC monitor near the digface to detect excessive radiation and VOC concentrations. Such measurements would help determine the level of shielding to safely handle waste containers. Visual monitoring by equipment operators and remote cameras during excavation and would be performed to identify fires, chemical compatibility issues (e.g., nitrate salts with organic material), anomalous material, and criticality issues. Samples of waste or soil would only be collected at the digface as a result of event-driven situations (i.e., visual occurrence of a chemical reaction or other unusual behavior that would be nonroutine). The excavator bucket and gantry crane would be equipped to collect this sample.

4.6.1.2.7 Containerization or Lag Storage—Waste and soil in the retrieval area would be placed into bins by the excavator or sizer (front-end loader). Bins would be located within mobile airlocks fitted and sealed to a rectangular hole at the base of the curtain. The airlock or bin would be positioned near the digface for ease of access and to minimize spreading loose material. The airlock would be equipped with a waste-addition hopper and an integral ventilation system that would minimize the potential for dust contamination outside of bins when they are filled. As filled bins are withdrawn from the airlock, lids would be placed on and clamped to the top. Surfaces of bins would be manually swabbed and checked for contamination. If present, contamination would be manually removed and surfaces would be painted, if necessary, to fix contaminants in place. Water used for decontamination would be collected and recycled through the system.

Decontaminated bins would be removed from the airlock and sent to lag storage where they would await further segregation before treatment. Temporary transportation routes would be within the AOC and surfaced with gravel or paved as needed.

In the lag storage area would be an initial counting of bins (or other containers) for the sole purpose of separating TRU from non-TRU waste streams. Once inside the processing facility, waste would undergo a more precise segregation. One of the most cost-effective and safest ways to make this determination would be to use NDA techniques rather than opening containers to collect samples.

4.6.1.3 Primary Technology—Ex Situ Treatment. All retrieved waste and soil would be transferred from lag storage to the waste processing facility for treatment. The processing facility would be designed and constructed as a Category 2 nuclear facility, and would include negative pressure process areas, airlocks, multiple contamination control zones, cascading ventilation systems, HEPA filtration and thermal-oxidation and acid-scrubbing units on building and process exhaust streams, and continuous monitoring of emissions. Proposed treatment steps for retrieved soil and waste are schematically portrayed in Figure 4-22. The treatment facility would be divided into separate areas for TRU and non-TRU waste. The following subsections describe shared treatment facility components as well as those used for separate treatment areas.

4.6.1.3.1 Treatment Facility Overview—The waste processing facility would have a common area with the remainder of the space divided into two major process areas, one for the TRU waste and the other for non-TRU. These areas are two completely separate, independent facilities with each having its own process equipment, ventilation systems, and contamination control zones. The common area would provide for the following functions: initial presorting, TRU and non-TRU waste separation, utilities, control rooms, data processing, and administration.

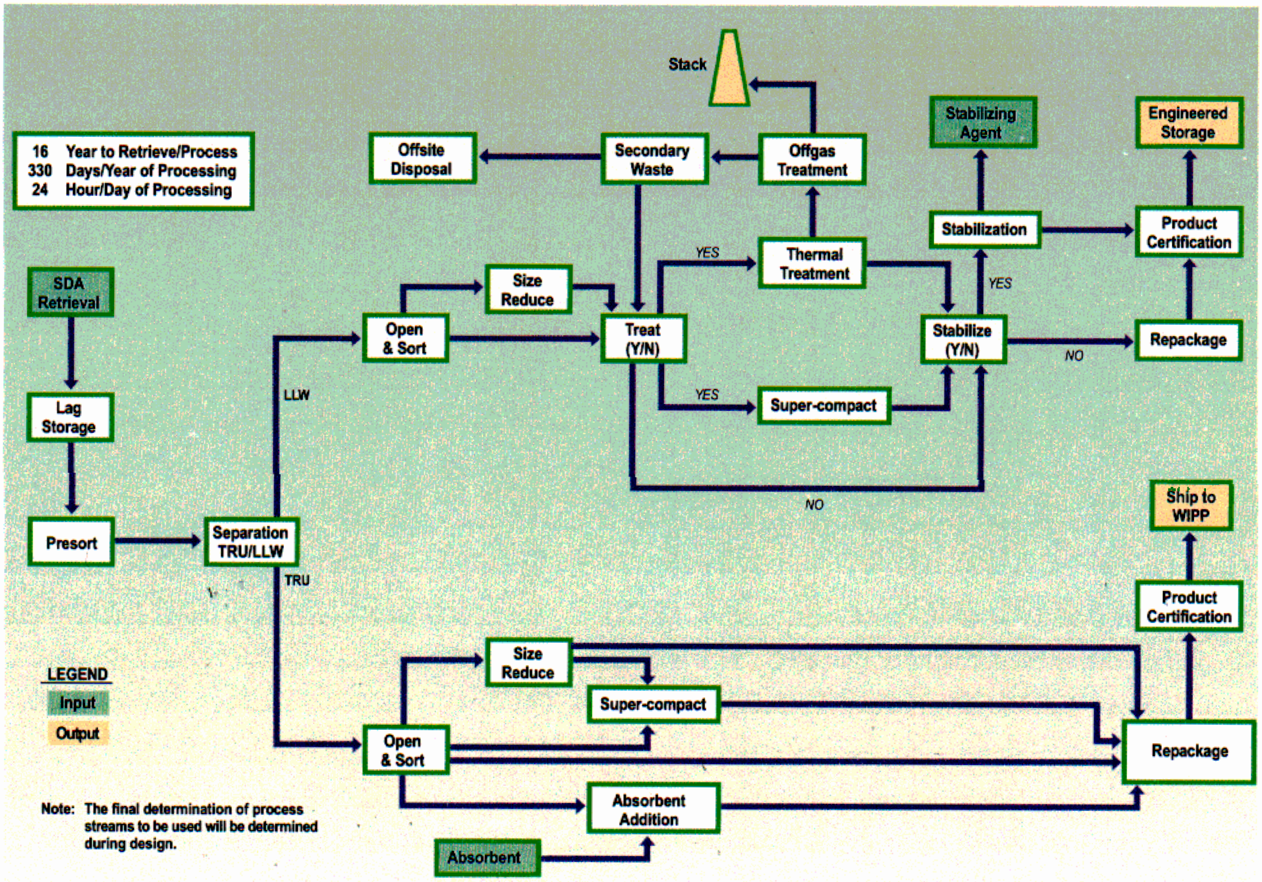

Figure 4-22. Process flow diagram for ex situ treatment.

Remotely operated equipment would be used to perform all processing of exposed waste. Manipulators, conveyors, and gloveboxes would be employed as necessary. Though provisions would be made for manned bubble suit entry into processing cells, this option would be employed only for nonroutine operations and maintenance. In some non-TRU processing areas, personnel using lesser protection may be allowed entry if the surface and airborne contamination levels are sufficiently low.

Cost estimates are based on the processing facility operating 330 days/year on a 24 hour/day, 7-days/week. One month is allowed annually for scheduled maintenance. A 75% availability factor has been applied (i.e., the system is down 25% of the time) to account for unexpected problems in any of the process lines. On this processing schedule, the facility would process approximately 46 m^3 (60 yd^3) per day, but would operate more days annually than the retrieval operations. The lag storage area would be designed to accommodate sufficient waste from retrieval operations, yet provide sufficient storage space for treatment facility downtime.

The actual containers and overpacks used to transport waste would be designed to optimize the retrieval and processing operations. Waste would be transported to the processing facility in 4 × 4 × 7-ft bins that have been overpacked in 5 × 6 × 8-ft containers. Using a 90% loading factor, approximately 16 overpacks with their inner boxes or bins of waste would arrive at the facility daily.

As discussed in Section 2, the exact split of the TRU versus non-TRU components of the RFP waste stream is uncertain. Assuming 50% of RFP waste is TRU, estimated quantities of waste and soil to be retrieved and the required processing rates are shown in Table 4-13.

Table 4-13. Volumes of waste and soil.

	Transuranic[a] Waste	Transuranic[a] Soil	Transuranic[a] Total	Non-transuranic[b] Waste	Non-transuranic[b] Soil	Non-transuranic[b] Total	Total Waste Plus Soil
Volume (yd^3/year)	2,400	2,200	4,600	4,200	10,000	14,200	18,800
Design (lb/hour)	500	1,000	1,500	900	4,500	5,400	6,900
Total volume (yd^3)	37,900	35,500	73,400	66,600	160,200	226,800	300,200

a. Transuranic waste estimate based on 50% of Rocky Flats Plant waste stream.
b. Low-level waste.

Safety issues in processing include fire prevention and suppression, prevention and mitigation of explosion hazards, contamination control, radiation shielding (a minor issue with this waste), and normal industrial hazards. The facility would be designed, constructed, and operated in accordance with all applicable regulations, codes, and standards. Criticality control is not anticipated to be a concern in this facility, but would be investigated further in the design phase of the project. Information gained during the OU 7-10 Glovebox Excavator Method Project would be used to reassess this issue during the project design phase.

4.6.1.3.2 Resorting and Transuranic and Nontransuranic Separation—Waste would arrive from the lag storage area in sealed waste overpacks containing boxes of waste and soil that were filled at the retrieval site. In the lag storage area, initial TRU and non-TRU separation would occur. Because of the volume of waste being shipped to the processing facility, multiple parallel process lines, each with its own loading dock, would be required.

Two options exist for transferring waste into the waste processing facility. In the first option, overpacks would pass directly through an airlock and into a presorting cell. At this location, lids would be remotely removed from waste overpacks and bins containing waste removed from the overpacks onto a presort table. Empty bins would be placed back in the overpack with lids reattached. The overpack would then move to a decontamination cell where the exterior surface of the overpack would be decontaminated. After a final survey, the overpack would pass back out through another airlock to a receiving truck, which would return bins and overpacks to the retrieval site for reuse. During final design, a transfer system patterned after the double lid, bagless transfer system used for 55-gal drum containers could be considered. In this option, the waste overpack would be mated to a transfer port and the lid would be removed. Remotely operated equipment would be used to transfer the bin containing waste to the presort table. After the bin has been emptied, it would be returned to the overpack. The lid would be reattached to the overpack, disconnected from the mating port, and returned to the retrieval site by truck.

For either method, waste would be transferred from the bin to the presort cell. Waste in the presort cell would be put into a condition that allowed it to be assayed and subsequently divided into TRU and non-TRU waste fractions. Presort processes could include an additional separation of soil from larger waste materials, opening selected drums or other containers to accommodate specific assay equipment requirements, and limited sizing. The degree of size reduction necessary to allow for accurate assay would be determined during design.

From the presort cell, waste would pass into the separation or assay cell where assay equipment would further separate waste and soil into two streams. Radioassay equipment would include segmented gate conveyor systems for soil and smaller waste sizes that could be placed on conveyors approximately 2-in. deep. This system is capable of assaying at a 100-nCi/g level at a rate of 22 tons/hour and diverting waste into two streams. Material containing concentrations greater than 100 nCi/g TRU would be sent to the TRU processing area of the facility. Material containing less than 100 nCi/g would be sent to the non-TRU processing area. The large-size waste would be placed in a favorable configuration for counting and then assayed with equipment similar to the box and drum counters currently being used in other DOE facilities.

4.6.1.3.3 Transuranic Processing Area—The TRU processing area would have a configuration similar to the AMWTP, including similar process lines and equipment. In this area, the TRU fraction of waste would be sized, treated, characterized, and packaged to meet transportation requirements and the WIPP WAC (DOE-WIPP 2002). Compared to the treatment for non-TRU waste, minimal treatment would be required for the TRU waste. Waste and soil sent to the TRU processing area would arrive in various physical and chemical forms and would first enter opening and sorting cells. In the cells, waste and soil would be removed from their containers (note that most retrieved drums and boxes are expected to be in a state of deterioration), visually inspected, sampled for chemical composition as necessary, and sorted for downstream processing. The intent of the inspection process is to identify and remove or treat prohibited items including liquids, pyrophoric materials, explosives, pressurized cylinders, material requiring neutralization, and flammable materials.

When necessary, real-time radiography would be used to provide information to assist in the opening of any intact waste containers that might contain prohibited items. Prohibited items detectable by real-time radiography include liquid waste and gas cylinders. Downstream processing would include adding absorbents for any free liquids, chemically neutralizing acids and caustics, and super compacting selected waste to reduce waste volume. To meet the WIPP WAC, necessary size reduction would be performed to allow efficient repackaging of waste in 55-gal drums or standard waste boxes, which provide an internal volume of 66.3 ft^3.

4.6.1.3.4 Nontransuranic Processing Area—In the non-TRU processing area, non-TRU waste and soil fraction would be processed, characterized, and packaged to meet the WAC for disposal in an onsite engineered disposal facility designed in accordance with the RCRA Subtitle C standards. Waste and soil to be retrieved are known to contain RCRA-regulated hazardous chemical contaminants, which must be treated to meet regulatory standards and address risk before disposal. These treatments would include chemical, physical, and thermal processes for removing hazardous organics and stabilizing regulated metals and radionuclides.

Much like waste sent to TRU processing, waste and soil sent to the non-TRU processing area would first enter an opening and sorting cell. There, it would be segregated into additional streams for processing. Waste would be screened to separate soil and smaller debris from larger pieces of waste. Some size reduction and drying might be required at that point to reduce soil clumps. The larger fraction would be separated by remote equipment into categories based on their ability to be shredded into smaller fractions. The degree of separation and sizing required would be a function of the final selection of thermal treatment equipment used. Large industrial shredders would be employed to reduce the size of the material as necessary.

Selecting technologies for ex situ treatment of remediation waste has been the subject of a number of previous studies at the INEEL. Currently, an evaluation is being conducted to select treatment technologies for the AWMTP facility, which is located adjacent to the TSA. A thermal treatment technology would be used to address the organic constituents within the waste stream. During a recent DOE assessment of treatment technologies (DOE 2000), steam reforming was identified as a most promising technology and a potentially viable alternative to incineration.

The U.S. Army Program Management for Assembled Chemicals Weapons Assessment is testing a continuous steam treater to destroy chemical munitions. The U.S. Army has performed two major pilot-scale test programs on the continuous steam treater and has had contractors develop the design basis and preliminary equipment specifications for full-scale operations. This technology has been reviewed by the National Research Council and the A. D. Little Company (i.e., U.S. Army's chief technical evaluator in the program). The continuous steam treater heats waste to drive off volatile and hazardous compounds. This is accomplished by blanketing waste with superheated steam that acts as a carrier gas and by heating the vessel wall with induction coils. To maximize processing rates, waste must be in a form that allows steam to reach all of the organic material as rapidly as possible. Processing steps include shredding of waste and, if needed, a carrier (e.g., carbon or lime) is used to ensure uniformity of solid flow within the unit. In the first stage, a horizontal chamber similar to a stainless steel shell would be used that incorporates an internal, slowly rotating auger. The continuous steam treater shell would have external inductive heating and 538°C (1,000°F) superheated steam inside. Superheated steam would pass through the continuous steam treater shell countercurrent to the waste feed flow.; Steam enters near where treated waste discharges and exits near the waste feed input. Inside the shell, the rotating, multibladed auger shaft rotates in a trough running the length of the shell to agitate, rotate, and move waste. Treated waste exits the shell through a rotary discharge airlock. Superheated steam, which acts as a carrier gas, now contains volatilized gases and exits the shell. Subsequent gas cleanup steps would include filters, scrubbers to remove corrosive acid gases, and HEPA filters, followed by reheat and catalytic oxidation to remove residual organics. Oxidation of carbon monoxide and hydrogen to carbon dioxide and water also would occur. Early removal of corrosive compounds (e.g., acidic compounds) should reduce metallurgical concerns about materials of construction. State-of-the-art filtration would limit particulate discharges to within acceptable limits. Finally, in-line catalytic destruction of pollutants (e.g., carbon monoxide and hydrogen) would ensure compliance with emission limitations while recovering inherent heat energy by generating needed process steam and power.

The proposed thermal treatment operation processing of the non-TRU waste and soil would result in a char-type residue. This residue would be stabilized in either a Portland cement grout or sulfur polymer cement. Both agents are effective for stabilizing and would meet applicable LDRs for waste disposal of ash and soil containing RCRA-regulated metals and radionuclides. The exact formulation and quantities of agent to be used would be determined during the project design phase. Stabilized waste would be placed in 55-gal drums. Larger, oversized waste would be placed in specially designed containers. Then containers would be moved to an engineered storage facility.

Secondary waste generated from non-TRU treatment would include scrubber blowdown solution, filters, and waste generated during routine operations and maintenance activities. The scrubber solution would be evaporated and resulting salts and residue would be stabilized as a solid and sent to the engineered storage facility with the other processed non-TRU waste. All other material would be processed through the facility with the exception of carbon filters containing low-vapor-point metals that might continue to be recycled through the process. These filters would be packaged to meet the engineered disposal facility WAC and sent to this facility.

Because of the wide dispersal of RCRA-regulated organic material disposed of in the SDA, all of the non-TRU waste and soil would be thermally processed. For a 16-year processing campaign, the design rate of the thermal treatment unit is estimated at approximately 5,000 to 6,000 lb/hour. A rotary treatment unit configured for this size is not unreasonable. Rotary kiln pyrolysis systems have been built and are being operated in Europe. These are used for municipal solid waste gasification offering capacities four to five times greater than 8,000 to 10,000 lb/hour. Depending on future and more detailed investigations, two or more rotary treatment units may be included to provide adequate spare capacity.

4.6.1.4 Primary Technology—Disposal. Waste and soil processed through the treatment facility would be characterized and designated for either off- or on-INEEL disposal. All processed materials would be taken from the treatment facility to an interim storage facility to await disposal. Transuranic materials designated for WIPP disposal would be temporarily stored in the enclosed structure adjacent to the treatment facility as described in Section 4.6.1.1. Treated MLLW and LLW designated for onsite disposal would be temporarily placed in a lined interim storage area constructed within the AOC and in accordance with federal and state requirements. The interim storage facility would separate waste by container type, weight, and known waste characteristics. The facility would be large enough to store containers for at least a year to await characterization results and to meet WAC. Discussions pertaining to off- and on-INEEL disposal of waste and soil are presented in following subsections.

4.6.1.4.1 Off-INEEL Disposal—Waste that meets the WIPP WAC (DOE-WIPP 2002) would be disposed of at WIPP, near Carlsbad, New Mexico, as shown in Figure 4-23. The WIPP facility is the only site certified for the disposal of TRU and mixed TRU waste and has a current design capacity of 175,000 m^3 (230,000 yd^3), which is expected to be filled by 2034. It is estimated that approximately 135,000 m^3 (175,000 yd^3) of RFP waste would be retrieved when implementing this alternative. As discussed previously in this text, the percentage of the RFP waste stream that would be classified as TRU is uncertain, but is projected to be on the order of 50%. Through sizing and compaction, the waste volume could be reduced by 25 to 33%. Even so, the projected volume of TRU waste and soil may represent 30% or more of the current WIPP design capacity and it is uncertain if it could be accommodated without approval to increase the disposal capacity. To increase the capacity at WIPP, the U.S. Congress would have to amend the WIPP Land Withdrawal Act of 1992 (Public Law 102-579). If WIPP is the only option for TRU disposal and its capacity is not expanded, load management techniques must be employed during retrieval, treatment, and packaging to reduce the volume of material destined for the facility.

The WIPP facility is exempt from federal LDRs in accordance with the WIPP Land Withdrawal Act Amendment of 1996 (U.S. Senate 1996). Before TRU waste could be shipped to WIPP, waste certification authority and transportation authority must be obtained from the U.S. Department of Energy Carlsbad Field Office, which includes extensive reviews and audits to verify the waste-generation site complies with all WIPP requirements. Transuranic waste would be certified by meeting the requirements specified in the WIPP WAC (DOE-WIPP 2002) and the “WIPP Hazardous Waste Permit” (New Mexico Environment Department 2002). To ship TRU waste to WIPP, requirements of the *TRUPACT-II Authorized Methods for Payload Control (TRAMPAC)* (DOE 2002) would have to be met.

Quality assurance activities must conform to the U.S. Department of Energy Carlsbad Field Office Quality Assurance Program Document (QAPD) (DOE 1999).

The following documents must be prepared by the INEEL for certification:

- Transuranic waste certification plan—documents how the INEEL complies with each requirement of the WIPP WAC

Figure 4-23. Route from the Idaho National Engineering and Environmental Laboratory to the Waste Isolation Pilot Plant.

- Certification quality assurance (QA) plan—documents how compliance with each quality requirement in the WIPP WAC is assessed by the INEEL

- Waste characterization QA project plan—explains in detail procedures and methods used for waste characterization

- Site-specific TRAMPAC—describes in detail how the INEEL complies with Appendix 1.3.7 of the Transuranic Package Transporter Model 2 (TRUPACT-II) safety analysis report for packaging as reflected in the WIPP WAC

- Packaging QA plan—describes the WAG 7 QA program for TRU waste packaging

- Sampling plan—supports the site-specific QA project plan and defines how waste containers are chosen for sampling on a waste-stream basis.

The time required to implement an acceptable program and grant certification authority depends on the complexity of the program being implemented, funding for site activities, and scope of certification audits. Complex programs may require several years to completely implement. To date, the INEEL has received certification for the RFP TRU waste stored in the TSA. Stored waste is expected to be similar to the material that would be excavated from the TRU pits and trenches.

Waste designated for WIPP disposal would undergo characterization and assay in the TRU processing area. Characterization during waste processing would include visual examination of the retrieved waste material and sampling and analysis of soil and waste for hazardous constituents and radionuclides. After waste is packaged into drums, each drum would be assayed to determine the isotopic ratios and quantities, and headspace gas samples would be collected and analyzed for VOCs and flammable gases.

Only one type of U.S. Nuclear Regulatory Commission-approved container is designed to carry contact-handled TRU radioactive waste to WIPP, the TRUPACT-II (DOE-NTP 2000). This container, shown in Figure 4-24, is composed of a protective stainless steel skin, a layer of insulation and foam, and an inner and outer containment vessel. The TRUPACT-II container is designed to carry 14 of the 55-gal drums, two standard waste boxes, or one 10-drum overpack (DOE-WIPP 2002). The TRU waste and soil would be packaged in 55-gal drums for this alternative. However, other larger containers may be approved at a later time that could lower costs.

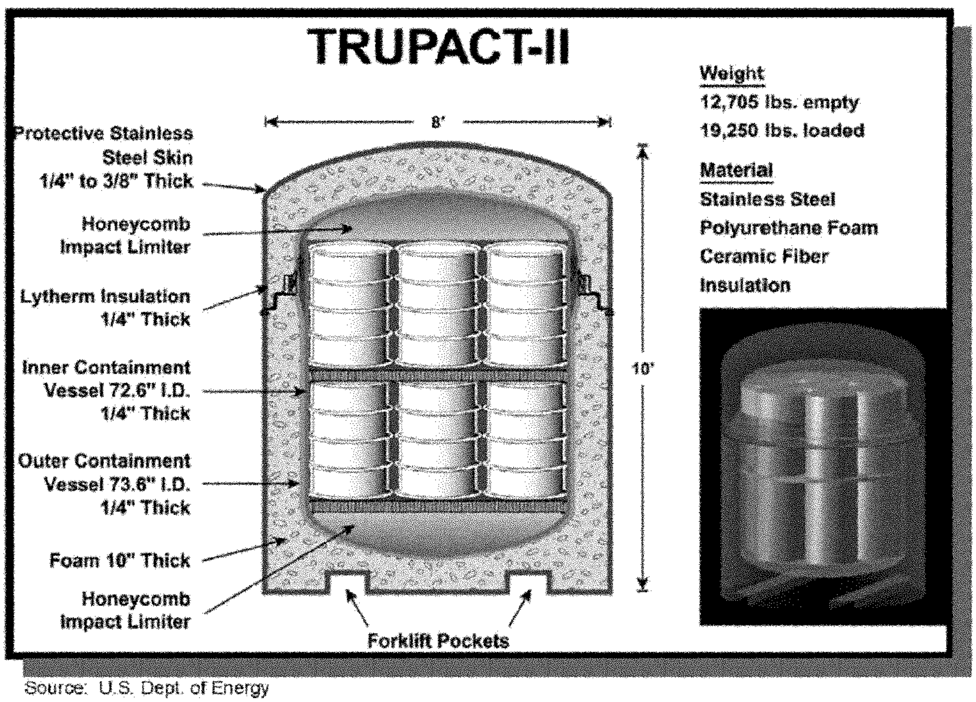

Figure 4-24. Packing configuration of the Transuranic Package Transporter Model 2.

4.6.1.4.2 Onsite Disposal—Non-TRU waste and soil processed through the treatment facility would be placed in an engineered disposal facility constructed within the SDA. The major components of the facility would include disposal cells (landfill) and evaporation ponds. Numerous steps involved in planning and designing this type of disposal facility include the following:

- Studies and assessments of site-specific geotechnical, seismic, subsurface consolidation, and slope stability

- Studies and estimates of landfill compaction and subsidence

- Evaluations of the long-term performance of proposed bottom lining and final cover systems, including test pad construction and evaluation

- Analysis and design of leachate collection, treatment, and disposal systems

- Analysis of various human and ecological risks and methods of control

- Preparation of detailed plans, specifications, and estimates, and a construction QA plan

- Preparation of plans and procedures for waste evaluation, WAC, tracking, treatment, and placement

- Preparation of a staff training plan, a storm water pollution prevention plan, a health and safety plan, an operations and management plan, an environmental monitoring plan, and a closure plan.

The onsite disposal facility would be planned, designed, constructed, operated, and closed in accordance with requirements identified for the proposed ICDF landfill. To minimize excavation requirements and minimize the footprint of contamination to the extent possible, the facility would be located where multiple pits had previously been excavated. The facility would be constructed within the AOC to allow flexibility in consolidating and remediating waste without triggering LDRs and other regulatory requirements. The projected location of the facility is shown in Figure 4-25.

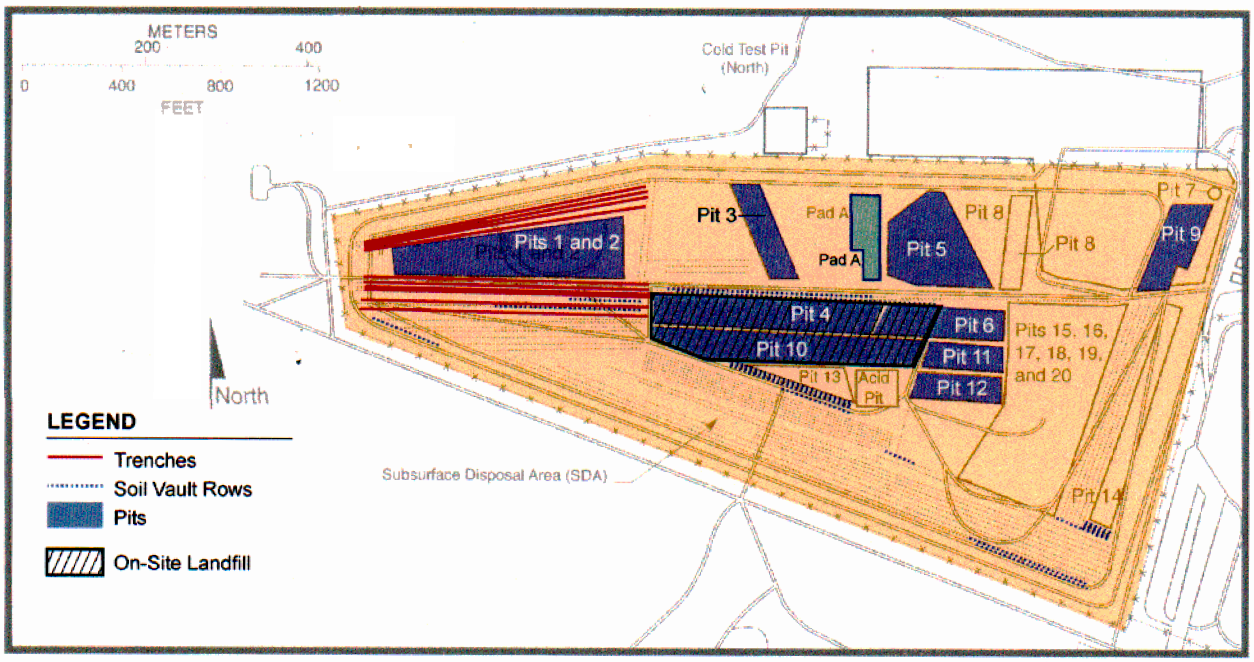

Figure 4-25. Proposed onsite location for a landfill within the area of contamination.

Capacity of this facility would depend on (1) quantity of retrieved waste classified as non-TRU and requiring onsite disposal, (2) increase in waste volume resulting from treatment, and (3) volume of cover soil used during facility operations. An estimated 175,848 m^3 (230,000 yd^3) of retrieved waste and soil would require onsite disposal. This volume of waste is assumed to increase by a factor of 1.2 to account for waste treatment. The resulting estimated disposal capacity required would be approximately 210,253 m^3 (275,000 yd^3).

Construction of the disposal facility would require excavating and shaping the landfill subgrade, installing lining and leachate collection systems, and constructing systems for leachate transmission, storage, and treatment. The leachate collection, transmission, treatment, and disposal system would consist of perforated collection piping on the bottom of the landfill, a leachate collection sump and evaporation pond outside of the landfill, and transmission piping to the sump and pond. An estimated 1,200 ft of perforated 12-in. pipe and 500 ft of nonperforated 12-in. pipe are estimated for the disposal facility. A 20-ft deep leachate collection sump would be constructed adjacent to the facility, with a pumping system for transmission of leachate to the evaporation ponds. Evaporation ponds would need to be sized appropriately for this facility. The alternative includes construction of two ponds with approximate surface dimensions of 200 × 350 ft and an average depth of 8 ft.

Waste entering the disposal facility would be controlled on the basis of source, physical form, and concentration levels in accordance with the established WAC. A uniform and consistent waste acceptance process would be implemented to include planning and waste certification. Developing chemical and radiological acceptance criteria for the landfill would include calculations to determine concentrations in the onsite engineered landfill leachate that protective the evaporation pond liner system and human health and the environment.

It is projected that the majority of materials disposed of would be treated and stabilized with cement. Stabilized waste would be delivered to the site primarily in 55-gal drums, 4 × 4 × 4 ft boxes, or 4 × 4 × 7 ft boxes. Some bulk disposal of contaminated soil and other waste might be allowed in the facility, if such material meets the WAC. The disposal facility also would accept material from the evaporation ponds, which would contain residues from evaporation of leachate and liquid residuals from treatment systems of the non-TRU processing area (e.g., evaporated salts from the scrubbed solution). Materials from the evaporation ponds would be assessed for compliance with the WAC and disposed of in bulk or treated and disposed of as necessary.

Waste would be placed in 5- to 10-ft lifts. Large, bulky materials or containers would be placed carefully in the disposal area to minimize the potential for damage to the bottom or sideslope lining systems. Clean soil would be used periodically to cover waste or stabilize containers as they are placed in the disposal area. Waste treatment and disposal would continue for 16 years concurrent with treatment operations, at which time the disposal facility would be closed. A description of the cap layers and potential borrow sources is provided in the description of the Surface Barrier alternative.

Closure also would involve decommissioning one of the evaporation ponds, a process that would include removing lining materials and filling the pond to grade with earth fill. The remaining pond would remain operational, as required, to collect and evaporate any leachate that accumulates in the disposal area after closure. Accumulated materials in this pond would be disposed of at another facility on the INEEL or at an off-INEEL facility. If monitoring of the remaining pond suggests that additional leachate is not being generated, then the pond would be decommissioned as described above.

4.6.1.5 Supplemental Technologies. To comply with the RAOs, this alternative requires implementing a number of supplemental technologies within the SDA to address contaminant-specific concerns and ensure long-term stability of the cover system.

4.6.1.5.1 In Situ Thermal Desorption—For this alternative, the ISTD technology would be used in some of the pits with elevated organic concentrations to remove VOCs from the waste and soil. Because of cost, health, and safety advantages, the majority of VOCs within the SDA would be removed before retrieval. Pretreatment would minimize requirements for ex situ treatment, emissions control, and worker protection. In situ thermal desorption would be applied in areas within the SDA containing high concentration of drums containing Series 743 organic sludge. Previous analysis (Miller and Varvel 2001) of the distribution of this waste stream, as depicted in Figure 3-8, estimates that a total area of less than 1 acre would have these high concentrations and require pretreatment. These areas are located in Pits 4, 6, 9, and 10.

A detailed discussion about implementing ISTD technology within the SDA is presented in Section 4.5.1.2. Specific pretreatment requirements would be determined further during the design phase.

4.6.1.5.2 Grouting—To comply with the RAOs, this alternative also would include applying ISG in the SVRs and in areas within the LLW trenches containing activation- and fission-product waste. Waste in these areas consists primarily of remote-handled materials, for which no off-INEEL disposal facilities currently exist. Implementing the ISG technology in these areas would be the same as described previously for the ISG alternative in Section 4.4 and addressed in the accompanying technical report (Armstrong, Arrenholz, Weidner 2002).

4.6.1.5.3 Backfilling and Cap Construction—Before excavated wastes sites are backfilled, characterization samples would be collected to verify that remedial action objectives were achieved and to document chemical and radionuclide concentrations left in place. As retrieval progresses, excavated areas would be systematically backfilled with clean fill. This could be done relatively soon after excavation, or after an entire site pit or trench was retrieved. Backfill would be compacted and the area prepared for cap construction. Before the cap is placed, subsurface stabilization using ISG would be conducted in unexcavated areas as necessary to minimize future subsidence-related maintenance.

This alternative requires placement of a low-permeability cap over the entire SDA to protect the site for the long-term. A modified RCRA Subtitle C cover, as described previously for the in situ treatment alternatives, is included in the RTD alternative. Constructing the final landfill cover would be conducted concurrently with retrieval activities. The final design would address required transition of the modified RCRA Subtitle C cover with thicker ICDF cover proposed for the centrally located onsite disposal facility. The transition must be designed to minimize future maintenance requirements.

4.6.1.5.4 Long-Term Monitoring and Maintenance—With stabilized waste remaining onsite, a long-term monitoring and maintenance program would be required to verify protectiveness of the remediation. Cost estimates for the RTD alternative include 100 years of monitoring and maintenance with reviews conducted every 5 years in accordance with CERCLA guidance. Initial monitoring requirements for groundwater, vadose zone, surface water, and air would be conducted as described for the in situ treatment alternatives. As with the ISV alternative, the monitoring program is reduced following the initial 5-year review in the cost estimates. The projected reduction would include 50% of the groundwater and lysimeter monitoring and elimination of the vapor port monitoring.

4.6.1.6 Schedule. The projected schedule of remedial activities for this alternative is presented in Figure 4-26. As shown, this alternative would require an estimated 30 years to complete. If the ROD were signed in the year 2005, then remediation would be complete in 2035. This would include an initial 6-year design (i.e., conceptual, preliminary, and final design) and comprehensive safety analysis effort. Design of the project would be phased for the ISTD and retrieval; it is not a continuous 6-year effort. The extended duration would be necessary to perform ISTD and obtain predesign characterization data. Characterization for soil cover removal and ISTD would be completed during this timeframe. After a year of subcontractor procurements, approximately 2-1/2 years would be needed to mobilize to the site and set up necessary facilities. Soil cover removal, followed by containment and infrastructure construction, would require another 2-1/2 years. The operational readiness review would commence at this point before retrieving waste. Waste retrieval (and concurrent backfilling and capping) and treatment would take place over a 16-year period. Final decontamination and decommissioning of the facilities would occur at the end of the project and the final cap would be installed over the backfilled areas.

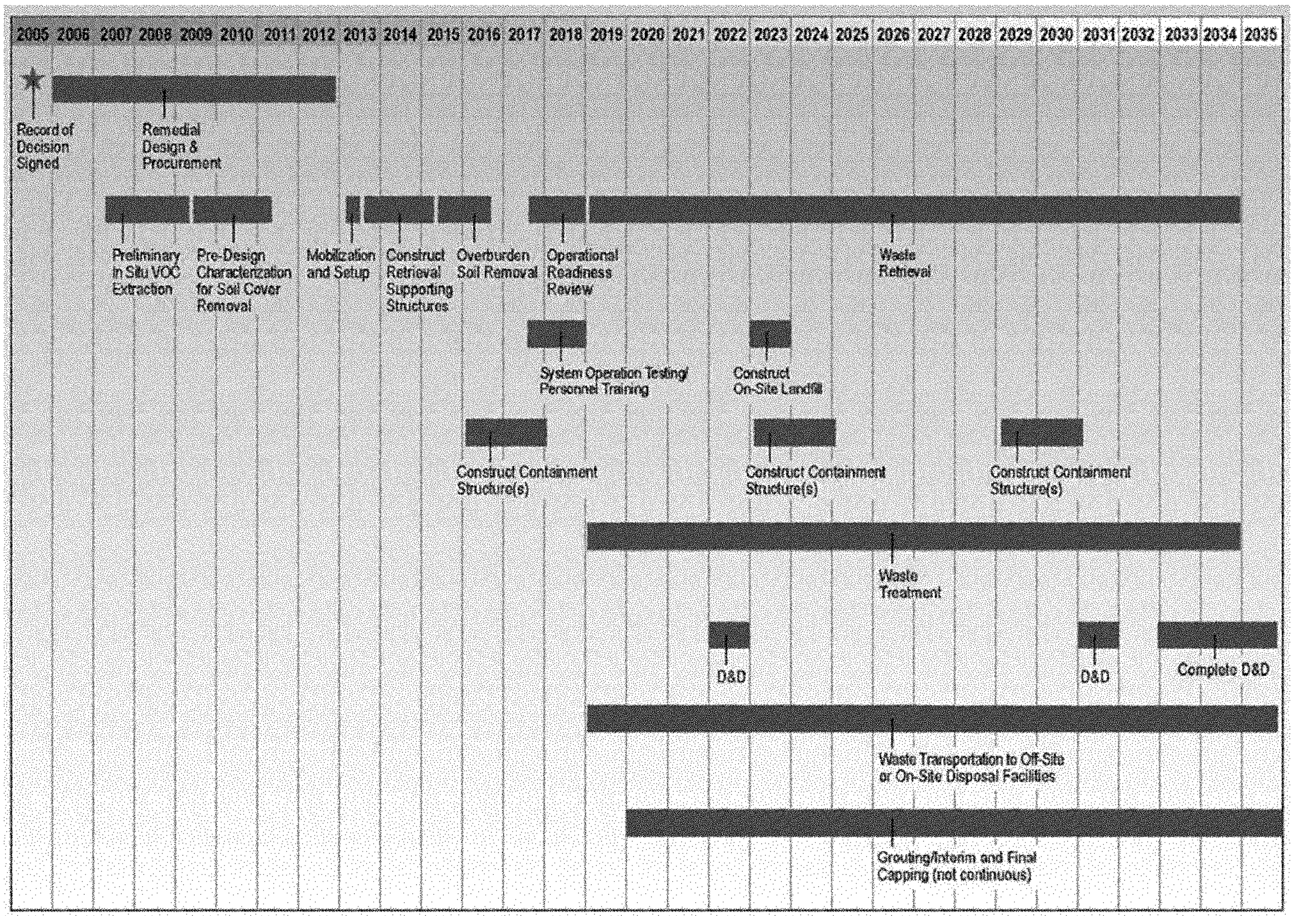

Figure 4-26. Schedule for the Retrieval, Treatment, and Disposal alternative.

As with any construction schedule prepared at this stage of the process, a high degree of uncertainty applies to this schedule. The RTD process flow is complex and requires integration and close coordination of a number of operations. Because of the potential variability in the waste stream and rigorous worker and environmental protection measures required, project delays to address site-specific issues should be anticipated.

4.6.2 Screening Assessment

The following sections provide an assessment of the ability of the RTD alternative to satisfy the two threshold and five balancing criteria described in Section 4.1.

4.6.2.1 Overall Protection of Human Health and the Environment (Threshold Criterion).

The RTD alternative is projected to protect human health and the environment and achieve project RAOs. For this alternative TRU waste would be retrieved and transported to an approved off-INEEL facility (i.e., WIPP) for permanent disposal. All LLW and MLLW in the TRU pits and trenches would be retrieved and treated in accordance with remediation goals and regulatory standards and placed back onsite in a secure, long-term disposal facility. Any remaining COC-bearing waste streams would be treated in place using ISG. The entire SDA would be covered with a long-term, low-permeability surface barrier designed to minimize future surface water infiltration and to inhibit human and biotic intrusions in remaining waste. Long-term future monitoring also would be conducted to evaluate effectiveness of the alternative.

Uncertainties exist as to whether human health and the environment could be protected adequately during RTD and shipping actions. Information gathered from a review of retrieval technologies (Sykes 2002) led to the conclusion that technologies exist to provide overall protection.

Implementing this alternative does not minimize the threat of exposure in the short-term (during remediation) because it adds a potential exposure route (i.e., radiation exposure to workers). Equipment operators, radiation control technicians, health and safety personnel, truck drivers, maintenance workers, and other personnel could be exposed to radiation and other hazards while implementing this alternative. However, the RTD alternative would minimize the long-term threat of potential exposure to human health and the environment at the SDA. These issues are discussed further in the following sections.

4.6.2.2 Compliance with Applicable or Relevant and Appropriate Requirements (Threshold Criterion). The RTD alternative involves the RTD of waste (both on and off of the INEEL) from the SDA. Under CERCLA, ARAR compliance is addressed by considering chemical-, location-, and action-specific ARARs and TBCs independently. Appendix A presents a broad summary of the potential ARARs and TBCs that have been identified. An evaluation summary of ARAR and TBC compliance for the RTD alternative is presented in Table 4-14. A discussion about some of these key requirements follows the table.

Table 4-14. Regulatory compliance evaluation summary for the Retrieval, Treatment, and Disposal alternative.

ARAR or TBC	Type	Relevancy[a]	Citation	Meets Evaluation?
Radiation protection of the public and the environment	Chemical Action	TBC	DOE Order 5400.5	Yes
Idaho toxic air pollutants	Chemical	A	IDAPA 58.01.01.585 and .586	Yes
Idaho ambient air quality standards for specific air pollutants	Chemical	A	IDAPA 58.01.01.577	Yes
National emission standards for hazardous air pollutants	Chemical	A	40 CFR 61	Yes
Native American graves protection and repatriation regulations	Location	A	43 CFR 10	Yes—if encountered
Preservation of historic, prehistoric, and archeological data	Location	A	36 CFR 800 and 40 CFR 6.301(b) and (c)	Yes—if encountered
Protection of archaeological resources	Location	A	43 CFR 7	Yes—if encountered
Preservation of historical sites	Location	A	Idaho Statute 67-4601 et seq. and Idaho State Historical Statute 67-4101 et seq.	Yes—if encountered
Compliance with environmental review requirements for floodplains and wetlands	Location	A	10 CFR 1022	Yes

Table 4-14. (continued).

ARAR or TBC	Type	Relevancy[a]	Citation	Meets Evaluation?
Protection of floodplains	Location	RA	Executive Order 11988; 40 CFR 6.302(b); 40 CFR 6 Appendix A	Yes
Remediation waste management sites located within floodplains	Location	RA	40 CFR 264.18(b)	Yes
Location standards for TSD facilities located within floodplains	Location	A	40 CFR 264.1(j)(7)	Yes
Idaho groundwater quality rule	Action	A	IDAPA 58.01.11.006	Yes[b]
Interim status standards for owners and operators of TSD facilities—groundwater monitoring	Action	A	40 CFR 265 Subpart F	Yes[b]
National ambient air quality standards	Action	A	40 CFR 50	Yes
Idaho control of fugitive dust emissions	Action	A	IDAPA 58.01.01.650, .651	Yes
Idaho fuel burning equipment—particulate matter	Action	A	IDAPA 58.01.01.675 through 681	Yes
Idaho particulate matter—process equipment emission limitations on or after July 2, 2000	Action	A	IDAPA 58.01.01.710	Yes
Standards for NESHAPs for source categories—waste combustors	Action	A	40 CFR 63 Subpart EEE	Yes
Polychlorinated biphenyls—storage and disposal	Action	A	40 CFR 761 Subpart D	Yes
Identification and listing of hazardous waste	Action	A	40 CFR 261	Yes
Standards for owners and operators of TSD facilities—landfill closure and postclosure requirements	Action	A	IDAPA 58.01.05 (40 CFR 264 Subparts G and N)	Yes
Standards for owners and operators of TSD facilities—use and management of containers	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart I)	Yes
Standards for owners and operators of TSD facilities—tank systems	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart J)	Yes
Standards for owners and operators of TSD facilities—surface impoundment	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart K)	Yes
Standards for owners and operators of TSD facilities—incinerators	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart O)	Yes
Standards for owners and operators of TSD facilities—miscellaneous units	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart X)	Yes

Table 4-14. (continued).

ARAR or TBC	Type	Relevancy[a]	Citation	Meets Evaluation?
Standards for owners and operators of TSD facilities—air emission standards for process vents	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart AA)	Yes
Standards for owners and operators of TSD facilities—equipment leaks	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart BB)	Yes
Standards for owners and operators of TSD facilities—tanks, surface impoundments, and containers	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart CC)	Yes
Standards for owners and operators of TSD facilities—containment buildings	Action	A	IDAPA 58.01.05 (40 CFR 264 Subpart DD)	Yes
Standards for owners and operators of TSD facilities—remediation waste management rules	Action	A	IDAPA 58.01.05 (40 CFR 264.1[j][1] through [13])	Yes
Hazardous waste determination	Action	A	IDAPA 58.01.05. 006 (40 CFR 262.11)	Yes
Land disposal restrictions	Action	A	IDAPA 58.01.05.011 (40 CFR 268)	Yes
National Pollutant Discharge Elimination System	Action	RA	40 CFR 122.26	Yes
Radioactive waste management	Action	TBC	DOE Order 435.1	Yes

a. A = applicable requirement, RA = relevant and appropriate requirement, TBC = to-be-considered requirement
b. Evaluation criteria met not including the vadose zone contribution.
ARAR = applicable or relevant and appropriate requirements
CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
IDAPA = Idaho Administrative Procedures Act
NESHAPs = National Emission Standards for Hazardous Air Pollutants
TSD = treatment, storage, and disposal

4.6.2.3 Chemical-Specific (Applicable or Relevant and Appropriate Requirements). As with the Surface Barrier, ISG, and ISV alternatives, the RTD alternative would meet the RAOs for direct contact because the surface barrier (cap) would prevent human and ecological receptors from direct exposure to soil and waste after excavation is complete. In addition, implementing the RTD alternative would satisfy groundwater RAOs because (1) the combination of waste treatment and disposal would reduce waste volume and toxicity and (2) a surface cover or barrier would reduce surface water infiltration. (Note that contributions to risk from postulated contamination previously released to the vadose zone are not addressed.)

Chemical-specific requirements of state and federal air quality standards would be met during construction and during remedial action implementation. State of Idaho requirements include those for toxic air pollutants (IDAPA 58.01.01.585 and .586), ambient air quality standards for specific air pollutants (e.g., particulate matter) (IDAPA 58.01.01.577), and emission of fugitive dusts (IDAPA 58.01.01.650). Federal requirements include NESHAPs (e.g., radionuclides) (40 CFR 61) and NAAQS (e.g., particulate matter) (40 CFR 50).

4.6.2.4 Location-Specific (Applicable or Relevant and Appropriate Requirements).

Location-specific ARARs for this alternative are the same as those for the Surface Barrier alternative.

4.6.2.5 Action-Specific (Applicable or Relevant and Appropriate Requirements).

Because this alternative leaves some waste in a new landfill, RCRA Subtitle C requirements for closure and postclosure (40 CFR 264 Subpart G) and landfills (40 CFR 264 Subpart N), as adopted by reference in the State of Idaho "Rules and Standards for Hazardous Waste" (IDAPA 58.01.05), are applicable. In addition, the substantive RCRA Subtitle C TSD requirements would be applicable depending on the treatment process selected. These TSD requirements include the following:

- Use and management of containers (Subpart I)
- Tank systems (Subpart J)
- Incinerators (Subpart O)
- Miscellaneous units (Subpart X)
- Air emission standards for process vents (Subpart AA)
- Equipment leaks (Subpart BB)
- Tanks, surface impoundments, and containers (Subpart CC).

The NESHAPs for hazardous waste combusters (40 CFR 63 Subpart EEE) also may be applicable to ISTD operations. These requirements would be met by using appropriate engineering controls.

In addition, RCRA groundwater monitoring standards (40 CFR 265 Subpart F) for using monitoring wells to detect the presence of COCs in the underlying aquifer are applicable to the RTD alternative, and provisions for groundwater monitoring are included in the RTD alternative.

The RCRA generator requirements for hazardous waste determination and management (40 CFR 262.11) would be applicable because potentially hazardous materials might be generated during RTD. Furthermore, RCRA requirements about disposal of hazardous waste in landfills also would be applicable (40 CFR 268 and IDAPA 58.01.05.011); however, a CERCLA waiver may be needed for onsite waste disposal. The WAG 7 area would be identified as an AOC. Because it is assumed that the AOC concept would be used when implementing the RTD alternative, waste consolidation and movement could occur without triggering RCRA Subtitle C requirements (e.g., LDRs). In addition, LDRs are not applicable for TRU waste shipped to WIPP because the Land Withdrawal Act Amendment of 1996 (U.S. Senate 1996) exempts WIPP from LDRs.

Because PCBs were disposed of in the SDA before 1978, any PCB waste retrieved would be subject to either the PCB spill cleanup policy or the self-implementing cleanup of PCB remediation waste. Both cleanup policies use risk-based approaches; consequently, it is believed that protective remedies implemented to prevent exposure to radioactive constituents also would be protective of any PCBs present. Disposal of this waste would depend on its concentration. Polychlorinated biphenyls in concentrations of 50 ppm or greater must be disposed of by incineration or in a chemical landfill, or by an alternate disposal method approved by EPA. Storage and disposal of any retrieved PCB waste would meet the applicable requirements of 40 CFR 761.61 and DOE guidance (DOE-EH 1999). Currently, WIPP is pursuing authorization to accept nonliquid PCB waste in concentrations greater than 50 ppm. It is assumed for this alternative that, at the time RTD is implemented, WIPP would be authorized to accept any nonliquid TRU waste with PCBs from the SDA.

Construction aspects of remediation would meet applicable requirements of state and federal air quality standards. State of Idaho requirements include controlling the following:

- Toxic air pollutants (IDAPA 58.01.01.585 and .586)
- Ambient air quality for specific air pollutants (e.g., particulate matter) (IDAPA 58.01.01.577)
- Emission of fugitive dusts (IDAPA 58.01.01.650)
- Particulate matter emission for fuel-burning equipment (IDAPA 58.01.01.675 through 681)
- Process equipment emissions (IDAPA 58.01.01.710).

Federal requirements include NESHAPs (e.g., radionuclides) (40 CFR 61) and NAAQSs (e.g., particulate matter) (40 CFR 50). These requirements would be met through appropriate engineering controls.

Organic vapors that accumulate beneath the barrier would be collected, removed, and treated by the active OCVZ treatment system (OU 7-08) and the designed passive gas collection layer within the proposed cover. The EPA Office of Air Quality Planning and Standards is developing a new MACT for the remediation site source category. This MACT, projected to be in effect after 2002, would apply to remediation sites that are a major source of organic hazardous air pollutants during site remediation activities. If applicable to CERCLA sites, all vents, remedial material management units, and associated equipment components involved in remediation could require emission controls. These requirements would be followed.

Institutional controls are often added to remedies to enhance long-term management protection and supplement engineered remedies (40 CFR 300.430[a][1]). Institutional controls of the RTD alternative would include security measures, access controls, fencing, and land use restrictions. These controls would help prevent possible exposure to waste by human intruders and biota. Controls also would meet applicable DOE requirements for residual radioactivity left in place, including the related provisions of DOE Order 5400.5.

As required, NPDES storm water discharge protection measures and best management practices would be implemented for controlling storm water, road building, waste management, and other related remedial activities as appropriate. Applicable DOE TBC requirements for protecting human health would be met during remedial activities.

All DOE radioactive waste would be managed so as to protect worker and public health and safety and the environment in accordance with DOE Order 435.1requirements.

4.6.2.6 Long-Term Effectiveness and Permanence (Balancing Criterion). The RTD alternative would provide long-term effectiveness and permanence, including the following actions:

- Removal of TRU waste and contaminated soil from the SDA and transport off-INEEL to a secure repository for permanent disposal

- Grouting-in-place of soil vault rows and trenches with high concentrations of fission and activation products to minimize further migration of these COCs
- Retrieval, treatment, and placement other LLW and MLLW containing identified COCs in an onsite engineered landfill
- Placement of a final protective barrier would be placed over all waste remaining onsite.

These actions would inhibit exposure of humans, plants, and animals to contaminants and would minimize contaminant migration to the groundwater. Because waste would remain at the SDA, long-term operation and maintenance activities, access controls, land use restrictions, and monitoring would be required as long as waste presented a hazard.

Although this alternative would effectively minimize future risk, it is projected that some COCs have already been released. The amount released to-date and current rates of release are not known with certainty. However, conservative estimates indicate that the preremediation release might result in groundwater contamination posing a risk greater than 1E-04. Modeling shows that this risk would peak by the year 2110 and would extend beyond the boundary of the SDA. Therefore, this alternative includes institutional controls that would prohibit using groundwater within this buffer zone. This zone could extend 1,500 to 2,000 ft from the SDA boundary.

In addition to prohibiting groundwater use within the buffer zone around the SDA, other institutional controls would be required to ensure RAOs are met and maintained. Land use restrictions would be required to prevent development, excavation, or drilling on and near the SDA. Frequent inspection and maintenance of the surface barrier would be required. The barrier would require periodic reconstruction every 500 years. Groundwater monitoring would be required to verify contamination does not exceed unacceptable levels beyond the institutional control boundary.

Long-term (10,000-year) modeling, in which any postulated contamination in the vadose zone is ignored, provides an indication of effectiveness of the RTD alternative in preventing migration of COCs remaining in the SDA burial zone. These results show this alternative would be effective in reducing contaminant migration and controlling groundwater ingestion risk from COCs in the burial zone at acceptable levels.

4.6.2.6.1 Risk Modeling Assumptions—Simulations show groundwater ingestion risks where the highest concentrations occur in the model. For the RTD alternative, all waste and associated COCs in the TRU pits and trenches were removed. Treatment and disposal of LLW and MLLW in a secure landfill was assumed to be effective in preventing release of contamination and hence, the model did not include any contribution from this disposed of waste. For the final surface barrier of this alternative, water was assumed to infiltrate at a rate of 0.114 cm/year.

For the grouted waste containing activation and fission products, contaminant releases from the grout were conservatively assumed to occur by diffusion from within 2-ft-diameter grout columns. These columns would be formed by injecting grout into the waste site on 2-ft centers to create columnar monoliths. For modeling purposes, the surface available for leaching was assumed to be the outside surface of the 2-ft-diameter columns. This is based on a conservative assumption that the points of contact between columns where cracks can form may be a zone of weakness. However, the surface area available for leaching is expected to be much lower, and limited data are available to accurately predict the extent of cracking that would form in the grouted waste over long periods of time.

The DUST-MS model assumed that infiltrating water would flow through columnar joints in the grout at volumetric rates equal to the surface area of the treated area multiplied by the infiltration rate. Volumes of water contacting waste in a given timeframe were assumed to dissolve the contaminants released in the same timeframe, up to their solubility limits in water. Concentrations of contaminants released from the source term were input to the TETRAD model for estimating groundwater concentrations and drinking water risk.

4.6.2.7 Magnitude of Residual Risk (Balancing Criterion). Figure 4-27 shows the cumulative carcinogenic risk over time caused by ingesting groundwater contaminated from grouted activated and fission product waste.

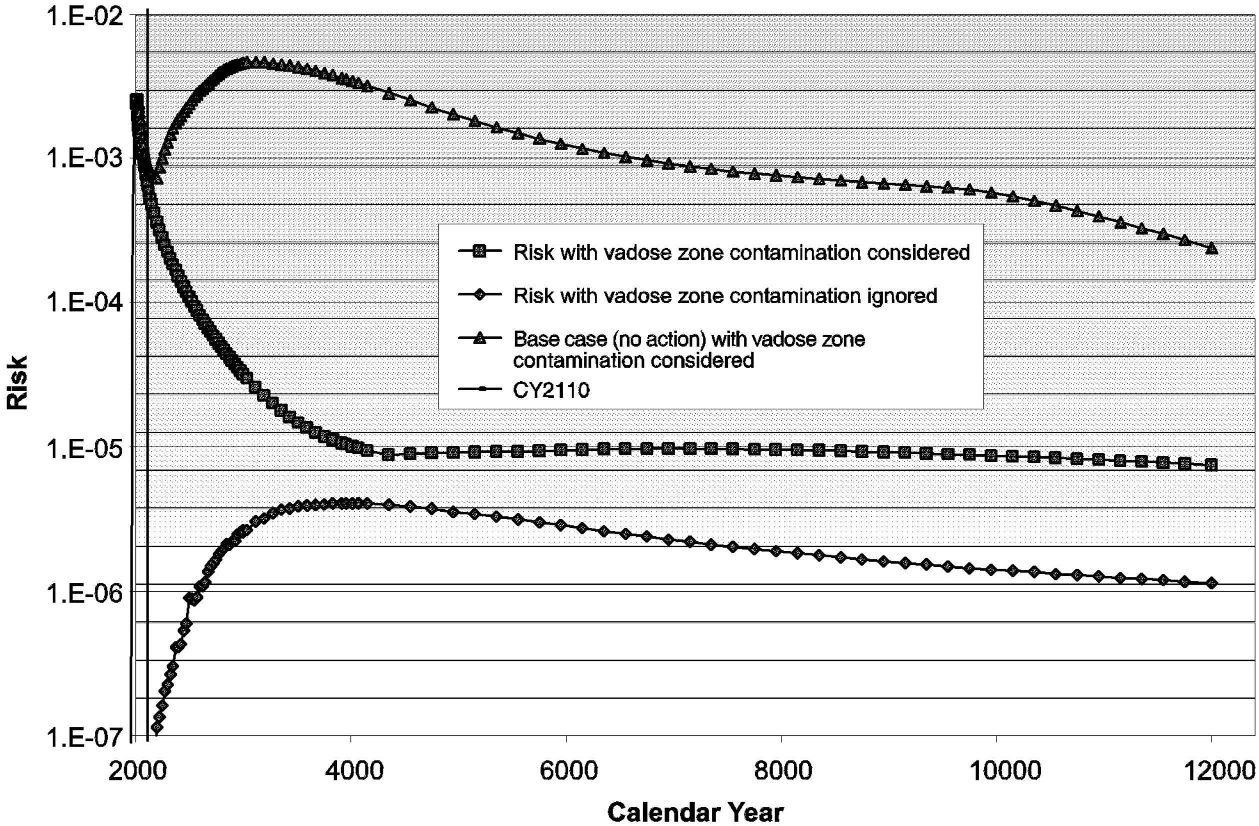

Figure 4-27. Carcinogenic risk for the Retrieval, Treatment, and Disposal alternative.

Figure 4-27 shows two risk projections: (1) risk associated with postremediation release of contaminants from the SDA source term only and (2) total risk represented by release of source-term contaminants, plus postulated contamination present in the vadose zone before installing a containment barrier over the SDA. As shown, carcinogenic risk associated with postremediation release of contaminants from remaining onsite waste would reach approximately 6E-06 in 2,000 years, then would progressively decrease to approximately 1E-06 in 10,000 years.

The residual hazard index for this alternative is assumed to be less than 1.0. The risk modeling indicates that the hazard index attributable to postremediation contaminant release under the Surface Barrier alternative would be less than 1.0. With treatment provided by ISG, the residual hazard index for the RTD alternative would be lower than that for the Surface Barrier alternative.

4.6.2.7.1 Adequacy and Reliability of Controls—Monitoring of remaining SDA waste, including treated waste buried in the engineered landfill and areas treated by ISG, would be required in perpetuity to ensure the effectiveness and permanence of the remedy. Regular monitoring (e.g., visual inspections and surface elevation surveys) would be performed to detect compromises in integrity or effectiveness of the barrier. The barrier would be maintained and repaired as required to achieve original performance standards. Because of the required life span of the remedy, portions of the barrier would require periodic repair or reconstruction, and that the entire barrier would be replaced every 500 years.

The long-term reliability and performance of the ISG remedy implemented for the activation and fission-product waste would be assessed through monitoring. A network of monitoring probes would be installed throughout the monolith before grout cures to collect moisture and vapor samples and monitor temperature, redox, and pH conditions over time.

To ensure protectiveness, active institutional controls would be required to limit land use activities in the vicinity of the SDA. A prohibition on drilling and using groundwater within a buffer zone around the SDA would have to be enforced. Access controls would have to be implemented and maintained in perpetuity to prevent intrusion into the waste.

4.6.2.7.2 Summary of Long-Term Effectiveness—Fate and transport modeling indicates that postremediation peak carcinogenic risk would be less than 1E-04 and the hazard index would be less than 1.0 for the groundwater ingestion pathway, if the postulated contamination in the vadose zone is not included. Retrieval and disposal of TRU waste and soil to an off-INEEL repository, coupled with treatment and disposal of the remaining waste in an engineered storage facility, would eliminate risk from exposure and minimize contaminant migration. The grout monoliths for activation and fission product waste would be chemically and physically stable over geologic time. Appropriate institutional controls, operation and maintenance programs, and periodic barrier repair and replacement would provide additional long-term control for the buried and stabilized waste.

4.6.2.8 Reduction in Toxicity, Mobility, or Volume Through Treatment (Balancing Criterion). As indicated, all waste sites contributing to the potential risk to human health and the environment would be retrieved and either disposed of off of the INEEL or treated and disposed of onsite. The TRU pits and trenches would be retrieved and disposed of off of the INEEL, with no appreciable treatment conducted other than sorting and repackaging. Retrieved MLLW and soil would be treated for hazardous components and disposed of onsite. Reductions in contaminant mass, toxicity, or volume would depend on hazardous components found. Treatment would destroy organic constituents and immobilize inorganic constituents of waste and impacted soil.

Grouting the SVRs and trench areas containing activation- and fission-product waste would reduce mobility of activation- and fission-product COCs in these areas. Further, constructing a low-permeability surface barrier throughout the entire SDA would minimize mobility of any contaminants remaining after remediation.

4.6.2.9 Short-Term Effectiveness (Balancing Criterion). Of all the alternatives, RTD would pose the greatest risk to the public and workers. Primarily, this would be caused by the retrieval process; subsequent onsite transportation, handling, and treatment processes; and transportation of TRU waste off of the INEEL for disposal at WIPP. The key components evaluated to determine whether the RTD alternative meets the balancing criterion would be (1) protection of the community during remediation, (2) protection of the remedial workers during remediation, (3) environmental impacts associated with construction, and (4) time until RAOs are met. The following subsections describe the performance of the RTD alternative for this criterion.

4.6.2.9.1 Protection of the Community During Remedial Actions—The RTD alternative is likely to pose increased risk and impact to the off-INEEL community because of increased traffic. Increased traffic would be anticipated during all phases of the project, and traffic control plans would be developed to minimize the impact and potential increase in transportation risk to the public and onsite workers. Using appropriate engineering controls and adhering to INEEL health and safety protocols would reduce the hazards. Shipping TRU waste off of the INEEL for disposal at WIPP would increase risk to the communities through which waste passes, although these risks would be mitigated by using engineered waste containers and proven waste transportation controls and processes.

4.6.2.9.2 Protection of the Remedial Workers During Remedial Actions—Potential implementation difficulties associated with the RTD alternative could increase risk to remediation workers. However, appropriate PPE, engineering controls, and adherence to INEEL health and safety protocols would reduce the hazards. Remediation workers may be exposed to radionuclides and VOCs while retrieving waste from selected pits and trenches. Earth-moving equipment, modified with positive-pressure ventilation-system cabs and HEPA filters, could be used to prevent exposure to radioactively contaminated airborne hazards. In addition, shielding equipment by placing lead lining on exterior surfaces of equipment would prevent worker exposure to ambient radiation hazards. Other risks to workers include physical hazards (e.g., earth-moving equipment, excavators, and other construction-related activities that could cause physical harm).

Hazards to the public and workers would be mitigated by construction of a containment structure around the area to be excavated, which would minimize potential release of contaminants. A negative pressure ventilation system would be installed in the containment structures to ensure that contaminants would not escape. To better capture contaminants from the source of generation, a laminar airflow hood or shroud could be used at or near the digface. During retrieval of selected TRU pits and trenches at the SDA, a system equipped with an aggressive means of contamination control would be applied at the digface to keep the generation of dust to a minimum. In a highly contaminated area, containment at the digface would consist of an engineered structure that would support ventilation systems and permit remote excavators, cranes, and vacuums to perform the operations. Another protective technology could consist of a system that provides different foams, soil fixatives, water- and dust-suppressant misters, in situ soil stabilization, jet-grouting cement of subsurface barrier walls (to allow vertical excavation), and vacuum systems (INEEL 1997). All characterization of waste and supporting treatment and packaging would be performed with stringent engineering controls and PPE to ensure worker safety. Continuous monitoring of operations and employees would occur throughout the duration of the project to ensure exposure to workers is ALARA.

Implementing ALARA concepts during waste retrieval operations would reduce worker exposures. In accordance with DOE orders, activities would be performed using the ALARA approach to protection from radiation. Training of personnel who use retrieval equipment, along with engineering controls and PPE, would be required throughout the project to ensure safety of workers on the project. Implementing appropriate health and safety measures would further minimize these risks.

Potential vehicle-related impacts include both physical accidents and inhalation of vehicle emissions, fugitive dust, and other particulate material generated during the transportation process. The likelihood of accidents outside of the INEEL increases with each loaded vehicle traveling to an off-INEEL destination, and it is estimated that approximately 7,400 truckloads would be required to transport the TRU waste to WIPP. However, the shipping containers for TRU waste have been demonstrated by the U.S. Nuclear Regulatory Commission to withstand extreme accident conditions without breaking open or releasing radiation. Therefore, it is highly unlikely that a release of radioactivity would occur even in the event of an accident.

Latent cancer risks from radiation exposure and the injury and fatality risks from physical hazards calculated for this alternative are summarized in Table 4-15 (Schofield 2002).

The risks associated with onsite activities were estimated based on a potential worst-case condition in which all RFP waste is classified as TRU waste. As shown, this evaluation predicts that during implementation of onsite RTD operations, approximately 62 onsite workers would develop cancer caused by exposure to hazardous substances, including radioactive material and radiation fields. The calculation projected that approximately 2,530 injury-related accidents and six fatalities would occur.

Table 4-15. Total cancers, mechanical injuries, and fatalities for the Retrieval, Treatment, and Disposal alternative.

Risks Associated with Onsite Activities	Number of Occurrences	Risks Associated with Off-INEEL Activities	Number of Occurrences
Cancer	62.30	Cancer	0.9
Injury	2,530.00	Occupational fatality	0.7
Fatality	5.67	Public fatality	2.7

INEEL = Idaho National Engineering and Environmental Laboratory

The risks associated with off-INEEL transportation activities presented in Schofield (2002) were scaled to account for 7,400 truckloads. During the off-INEEL transportation of the TRU waste to WIPP, approximately four deaths resulting from traffic-related accidents are projected for drivers and the public.

Short-term risks also were quantified for an off-normal occurrence (accident) during remediation (Schofield 2002). These risks are portrayed in terms of the effects on a maximally exposed individual. The worst-case unmitigated accident scenario established for the RTD alternative was for a worker exposed to a high concentration of airborne radiological activity. For this event, it was assumed that a heavy equipment operator inadvertently uncovered a large pocket of highly contaminated soil resulting in the resuspension of large amounts of contaminated particulate matter. The soil pocket is assumed to contain 6.5E+03 Ci of Pu-239 (approximately 10% of the reported SDA inventory). On hearing the air monitor alarm, the operator, who would be wearing an air-supplied hood, would take 3 minutes to exit the primary containment area. The lifetime cancer risk for operators is estimated to be 3.12E-02. It is assumed for this scenario that the ventilation system would be effective in retaining the particulate matter and that receptors outside the primary containment structure would not be exposed.

This alternative also includes an environmental monitoring component that would require controls for the health and safety of personnel. Procedures are currently in place that use engineering and administrative controls and PPE to ensure worker protection during monitoring activities. In the event that the existing monitoring network is expanded as part of this alternative, engineering, administrative, and PPE measures would be used to adequately protect workers during installation. Through past waste retrievals, the INEEL has demonstrated the ability to use engineering and administrative controls for worker protection (Sykes 2002).

4.6.2.9.3 Environmental Impacts Associated with Construction—Environmental impacts associated with the RTD alternative include landscape modifications and particulate emissions associated with retrieval activities and increased construction-related traffic. The surrounding landscape would be disturbed by equipment and vehicles moving in and around the site. Particulate emissions would be controlled with dust-suppression techniques as necessary to ensure that the rate of exposure to off-INEEL receptors would not exceed either the 25 mrem/year for total effective dose equivalent from all exposure pathways, or the 10 mrem/year for total effective dose equivalent through the air pathway, in accordance with DOE Manual 435.1-1. Radiological occupational exposures would be kept ALARA and below the limits set forth in 10 CFR 835.202 and "Radiation Protection—INEEL Radiological Control Manual" (PRD-183) of less than 2 rem/year for each worker.

After all waste has been processed, the processing facility would undergo a D&D&D phase. All LLW and MLLW associated with the D&D&D would be disposed of at the engineered storage facility. Any TRU waste associated with the D&D&D would be disposed of at WIPP. All process buildings would be removed and the site restored.

4.6.2.9.4 Time Until Remedial Action Objectives Are Met—The RTD alternative is projected to require the longest time to implement. In addition, many factors could affect time required to implement, design, construct, and operate the RTD alternative. These factors involve documenting and approving the activity in a timely fashion, available capacity at WIPP to dispose of the retrieved TRU waste, and actual production rates achieved during excavation and treatment. Several retrieval actions could be undertaken simultaneously to meet more aggressive schedules. Conversely, if several remediation projects were undertaken simultaneously, other technology components would be affected because several treatment and storage facilities would have to be constructed and operated. A more aggressive schedule also would increase frequency of shipments to WIPP, and the shipping schedule would have to be modified to handle the load.

4.6.2.10 Implementability (Balancing Criterion). Implementing a large-scale retrieval action at the SDA would be complex because a project of this magnitude has not been attempted before. Evaluations have been performed on retrieval technologies and the most recent excavation experience has been reviewed to determine construction and operation issues associated with this type of project. Many issues arise when evaluating the feasibility of implementing various technologies. Major issues that affect technical feasibility of the alternative are discussed below and are organized to progress through the various components of RTD to identify those with proven implementability, as well as those parts of the alternative where implementation may be difficult. In addition, technical feasibility is discussed by evaluating similarities between other retrieval projects for similar waste and the applicability of these projects to the RTD alternative. In addition, administrative feasibility and availability of needed services and materials is presented to assess the overall implementability.

4.6.2.10.1 Implementability of Preretrieval Activities—Removing soil cover at the SDA with a bulldozer, stockpiling material for characterization, and then using the soil as backfill would be feasible. Characterizing the topsoil layer before removal would aid in determining its disposition. Some areas may not be removed if (1) the material is not clean (e.g., such material would be retrieved with waste as contaminated soil), or (2) the material is providing shielding from the radioactive waste in that location. Removing soil cover should not lead to schedule delays.

In situ thermal desorption would be performed before waste retrieval to remove more than 80% of the VOCs in the waste. Initial VOC extraction could be done before soil cover removal, depending on design requirements. The ISTD systems could be constructed and operated in most locations, although a few isolated locations might not be amenable to VOC extraction (e.g., areas with low VOC content or areas with a lot of oversized debris). Extracting the VOCs before excavation is projected to be more advantageous than addressing health and safety and waste issues associated with high VOC content during excavation, and subsequently in the off-gas during RTD.

4.6.2.10.2 Implementability of Retrieval Activities—Double containment is projected to be necessary for those actions that could potentially involve source release. The primary and secondary containment structure selected for this alternative would provide this containment. Most of the pits are small enough that one containment building could cover the entire pit. Several pits are too large (larger than the average span of a 200-ft building) and two buildings would be necessary. This means that structural support for the buildings (e.g., H-piles, shoring, or soldier piles) would be placed through the waste to anchor the building to bedrock. For the trenches, the containment structure would be constructed in a similar manner with no unique construction or operation issues. Therefore, several trenches could be housed within one containment building because trenches are adjacent to each other and fairly narrow. Other waste-disposal locations (e.g., SVRs located near or between trenches to be retrieved) could be identified before construction and would be left in place. Metal curtains hung from the gantry crane could be constructed, but sealing the curtains and maintaining negative pressure and proper airflow are implementation issues to be resolved during design. Using the curtain as a barrier to confine the excavation, but not as an airseal or containment, is feasible.

Contamination controls needed for decontamination, fixation, dust suppression, and source control are available (e.g., foggers, misters, fine sprays, and strippable coatings) and are anticipated to be attainable to construct or operate. Minor contamination issues within confinement and containment could be mitigated and controlled.

The source control ventilation system attached to the containment structure and used within the confinement at the digface would use a hose system to draw air and airborne particles downward to the floor of the excavation for collection. Details of this system would be developed during the design phase and the optimum system configuration would be obtained.

Manned and modified standard equipment is the most implementable option for the retrieval equipment, although it is anticipated that effective remote equipment would be available for consideration during design. Cranes were viewed as less versatile than excavators because supports needed to construct and operate cranes would make them more difficult to move to a new site. However, constructing and operating the crane for contamination control and fire suppression were deemed straightforward and would be used to complement the standard excavator.

One of the greatest control risks would be the maintenance personnel who routinely enter the contaminated work areas to work on the retrieval equipment (Sykes 2002). Provisions must be in place to allow retrieval equipment to be driven into a controlled maintenance area adjacent to the work area so a more protected environment could be established. Entrance into the contaminated work area for retrieval equipment maintenance should be limited to nonroutine activities to control risk.

A front-end loader and a backhoe for sizing and sorting would be needed within confinement curtains to (1) clean sidewalls of the excavation, (2) move material within the confinement, and (3) cut, size, and sort the material for placement into waste bins. Recent experience at Hanford showed that two pieces of dedicated equipment could be operated within the containment area to increase production rates and facilitate digging, sizing, and sorting actions. The evaluation considers construction of hermetically sealed equipment for this type of operation and operating this equipment in the SDA environment as feasible. Having an operator using PPE in the cabs of the equipment (with supplied air if deemed necessary) is a proven type of operation regarded as feasible. Equipment would require standard maintenance and would be replaced several times during the project lifetime. Many end-effectors (e.g., different-size buckets, some with claws, some toothless; cutters; and grapplers) would be located adjacent to the working digface and are readily available and proven. Previous experience indicates that metal bands wrapped around containers would catch on the equipment (as has occurred during previous retrievals and the cold test [Sykes 2002]) and would have to be cut loose. A second piece of equipment at the working digface would make this a relatively easy operation.

The technique of benching down the excavation and forming a working face in a pit is feasible because waste is relatively compact in clay-type material. Photographs of buried waste during retrieval at many of the pits (EG&G 1978; Thompson 1972) show that the material is relatively compact, so extreme sloughing should not occur. If the equipment breaks down, manned entry into maintenance areas is deemed feasible with the availability of contamination controls and airlock systems. However, redundant systems need to be employed to ensure continual operation. Significant lost time could occur if unknown or unanticipated conditions were encountered, as was the case for the operation at the Hanford 618-B-4 Project. The primary lesson learned from the Hanford Project was that unexpected quantities or types of anomalous waste materials unearthed resulted in schedule delays and the suspension of operations (Sykes 2002). Establishing a second concurrent retrieval action would alleviate this concern, but the treatment system, lag storage area, and many other systems would have to be sized accordingly.

For the trenches, constructing and operating the necessary technologies to retrieve, treat, and dispose of the buried waste is technically feasible. Operational issues needing to be resolved during design are (1) methods for handling the large volume of clean and contaminated soil between the trenches, (2) SVRs that are between the trenches, and (3) isolated waste disposal locations present in the containment (if any are found). Shoring the sidewalls and maintaining structural integrity of the waste would be implementable.

Keeping the retrieval operation contamination-free would prove difficult. During previous retrieval actions at the SDA, the nature of the waste complicated the retrieval and slowed digging operations. The discovery of many seriously damaged barrels necessitated hand digging and lifting. It was recognized that the main problem inherent in mass techniques is the difficulty in achieving contamination control in areas where cardboard cartons and wooden boxes are buried and interspersed with barrels (Sykes 2002). To maintain control of contamination spread, material may be laid down or sprayed on the excavation floor and in dedicated maintenance areas so that equipment driven over the area would not resuspend the contamination. Spills that occur at the digface could be handled with standard equipment and operations. The design effort would determine appropriate trigger points and action levels for spills and reportable quantities for SDA waste retrieval.

Monitoring at the digface for the RTD alternative includes only health and safety monitoring (e.g., visual, gamma, VOC, and fire monitoring and simple chemical testing). Characterization for waste treatment would not be performed at the digface. Gamma detection monitoring also could be used for waste segregation to increase precision of retrieval, but this is a secondary benefit of the equipment. No special equipment would be used for characterization except under nonroutine conditions when a sample could be collected from the excavator bucket. This monitoring program is technically feasible and easy to construct and operate. The observational approach, along with shipping records and previous remediation experience, would be used to keep the operation simple.

Backfilling the sites would be technically feasible and operation and construction issues would be minor. Similarly, packaging waste and soil would be technically feasible and materials would be readily available. However, packaging material must be compatible with waste disposal and characterization requirements. Screening each waste bin to determine the TRU or non-TRU nature of the material would employ NDA. Supersacks used for soil also are not amenable to current TRU NDA because of their large size and the heterogeneity of the soil. This package option also requires further development to determine and demonstrate an implementable approach.

4.6.2.10.3 Implementability of Treatment Activities—Constructing and operating the waste processing facility would be technically feasible. Handling TRU-contaminated materials has been done routinely and safely at Rocky Flats Plant (the source of most of the SDA waste) for many years. The AMWTP being constructed adjacent to the SDA is scheduled to begin processing TRU waste from the TSA in 2003,. Steam reforming is sufficiently understood, has been proven, and would be implementable. The reliability of steam reforming is high compared to other large thermal processing systems. The necessary off-gas equipment also would be similar and implementable. Sufficient technical expertise currently exists to successfully design and construct this facility.

Because using thermal treatment for processing radioactive waste on this large scale has not been done before, development effort (including large-scale testing) would be required before making a final commitment to this technology. Development efforts would concentrate on (1) performance of drum-treatment units, (2) steam-reforming chemistry for the waste to be processed, (3) off-gas treatment including catalytic oxidation, waste feed and discharge systems, and (4) containment issues (e.g., kiln seals if a kiln system were selected).

4.6.2.10.4 Implementability of Onsite and Off-INEEL Disposal Activities—For onsite disposal, implementability issues revolve around regulatory concerns that would dictate specific treatment standards or design requirements for the onsite storage facility. However, some RCRA hazardous waste has been buried in the SDA. Similar waste disposed of in the TSA included 25 listed and characteristic waste codes, including D and F codes. Excavating RCRA waste in the SDA could trigger RCRA Subtitle C requirements (e.g., LDRs) requirements, which would potentially dictate performance- or technology-based treatment standards. However, because WAG 7 would be identified as an AOC, the CERCLA process allows moving and consolidating waste within the AOC without triggering LDRs. Pretreatment requirements for TRU waste would not be affected because shipments to WIPP are exempt from LDRs.

For off-INEEL disposal, current capacity of WIPP may pose an issue for this alternative. If the additional TRU waste generated from implementing the RTD alternative exceeds available capacity at WIPP, then another amendment to the WIPP Land Withdrawal Act Amendment of 1996 to expand the capacity at WIPP would be required or an alternative disposal option would have to become available. Current estimates of the total volume of material to be disposed of at WIPP from the RTD alternative represents about 35% of the current capacity of WIPP.

Another implementability consideration is the magnitude of transportation requirements to WIPP and associated environmental concerns. To transport the currently projected volume of TRU waste, more than 7,400 truckloads to WIPP would be needed to complete the project. This would have some impact on roads and communities adjacent to the INEEL and is similar to the number of TRU waste shipments planned from Hanford.

4.6.2.10.5 Technical Feasibility—An evaluation of case studies of past retrieval operations and the remedial design recently completed for OU 7-10 supports the conclusion that manually operated retrieval of most types of buried waste would be technically feasible. A list of historic retrieval operations involving mixed radioactive buried waste is presented in Table 4-16.

A careful analysis of the retrieval work performed indicates that the success of all the actions depended on the type and condition of the waste encountered. In previous INEEL projects, otherwise successful retrieval campaigns were thwarted in certain areas when severely deteriorated containers and high levels of airborne contamination were encountered. These past demonstrations lead to the conclusion that drummed waste streams could be retrieved if airborne contamination is adequately controlled to protect remediation workers.

The Glovebox Excavator Method retrieval system, currently under construction at Pit 9 (OU 7-10 Stage II), consists of a fabric weather enclosure structure, steel retrieval confinement structure, excavator, ventilation system, and other supporting equipment. Excavation will commence in 2003, and will clearly demonstrate the technical feasibility of limited retrieval in the SDA. Overburden will be removed to a specified depth, then the excavator arm contained within the retrieval confinement structure will excavate a semicircular swath of waste zone material. The retrieved waste zone material will be placed in a transfer cart by the excavator bucket. One transfer cart will be located at the entrance to each of the three material-packaging gloveboxes. The transfer carts will transport waste zone material inside the gloveboxes where the material will be inspected, segregated where necessary, and sampled. Each of the three gloveboxes will be equipped with three drum bagout stations for packaging the material into 55- and 85-gal drums. The *Technical and Functional Requirements for the Operable Unit 7-10 Glovebox Excavator Method Project* (INEEL 2002) sets the technical baseline for the project.

Table 4-16. Summary of retrievals performed by the U.S. Department of Energy.

Retrieval Description	Year
RFP Trench 1 Burial Ground	1998
Hanford 300 Area 618-4 Burial Ground	1998
Los Alamos Area P Material Disposal Area Technical Area 16	1997
Sandia Radioactive Waste Landfill ER Site 1 and Chemical Disposal Pits ER Site 3	1996
Maralinga	1996
Calvert City	1980s
INEEL SDA Initial Drum Removal Project	1974
INEEL SDA Early Waste Retrieval Project	1974
INEEL SDA solid radioactive waste retrieval test	1972

ER = environmental restoration
INEEL = Idaho National Engineering and Environmental Laboratory
RFP = Rocky Flats Plant
SDA = Subsurface Disposal Area

Table 4-17 provides a summary of technical elements required for the RTD alternative. The level of development is presented for each technology. As shown, many of the technologies required for the RTD alternative have reached advanced stages of development and are commonly used in industry. However, some technologies would require additional development.

Table 4-17. Summary of Retrieval, Treatment, and Disposal alternative remedial elements and levels of development.

Remedial Elements	Level of Development[a]
Remove overburden soil with dozer	5
Characterize overburden soil	5
Perform in situ VOC extraction of buried TRU waste	2
Construct containment structures	5
Construct and operate gantry cranes	5
Apply contamination controls	2 through 5, depending on type used
Construct and operate hermetically sealed equipment	4
Construct and operate airlocks in containment	4
Monitor gamma radiation and VOCs at digface	5
Use the observational approach for excavation	5

Table 4-17. (continued).

Remedial Elements	Level of Development[a]
Perform thermal treatment for non-TRU waste	5
Perform TRU treatment	3
Construct and use waste bins for waste and soil	5
Construct and use NDA to separate TRU in 55-gal drums	5
Construct and use NDA to separate TRU in bins or supersacks	4
Construct and operate onsite landfill	5
Dispose of TRU at WIPP	5

a. Key
1 = Based on theoretical concepts and engineering judgments.
2 = Concept is similar to, but not the same as, other demonstrated applications.
3 = Concept has worked at smaller scale.
4 = Concept is demonstrated in a few applications.
5 = Concept is a common industry practice or has been demonstrated many times.

NDA = nondestructive assay
TRU = transuranic
VOC = volatile organic compound
WIPP = Waste Isolation Pilot Plant

4.6.2.10.6 Administrative Feasibility—Though actions would be implemented under CERCLA for OU 7-13/14 that would not require permits, substantive provision of permits that would otherwise be required are considered to be ARARs. Because the RTD alternative would adequately address identified ARARs, no known administrative barriers exist to prohibit implementation.

For the RTD alternative, potential administrative feasibility issues would revolve around regulatory concerns, which would dictate specific treatment standards and design requirements for the onsite disposal facility. For example, a considerable amount of hazardous waste buried in the SDA might be similar to waste currently stored in the TSA. For the TSA waste, at least 25 listed and characteristic waste codes are identified. Excavating hazardous waste from the SDA could trigger additional substantive requirements that would potentially dictate performance- or technology-based treatment standards.

One challenging issue with any remedial action taken at the SDA would be demonstrating readiness to conduct safe operations and obtaining administrative approval to commence operations because of the nuclear hazards. The RTD alternative activities would expose the buried waste and pose a risk for contamination. The process of safety analysis, design, and demonstration of operational readiness for systems and techniques to remove and treat the waste would be complex. However, based on the safety analysis and design work completed for OU 7-10, these issues would be adequately mitigated with proper design and operations for identified SDA waste streams.

4.6.2.10.7 Availability of Services and Materials—Equipment and structures required for a retrieval action would have to be built specially for this project because of the nature of the waste and site conditions. Examples include remote equipment, containment structures, ventilation systems, contamination control devices, treatment units, storage facilities, monitoring devices, and packaging facilities. In addition, workers required to implement this alternative would have to be specifically trained.

Availability of sufficient capacity at WIPP could be an issue, and the additional TRU waste generated from the RTD alternative could exceed the available capacity by approximately 25,000 m^3 (32,700 yd^3) assuming current waste projections for all the TRU waste generators are accurate. However, additional capacity could be made available if the U.S. Congress amends the WIPP Land Withdrawal Act Amendment of 1996.

4.6.2.10.8 Implementability Summary for Retrieval Alternative—Overall, the RTD alternative is technically feasible and implementable. In summary, the primary technologies that might require further development include thermal treatment as applied to the SDA waste and its off-gas system, TRU analysis, fogging systems, and remote operations to support treatment. Thermal treatments described in previous sections are reasonably demonstrated technologies for a wide range of contaminants including PCBs, pentachlorophenols, chlorinated rubbers, wood, debris, and soil.

If personnel are not allowed to operate retrieval equipment within the dig-face area because of safety, administrative, or other concerns, then using remote technologies would be required. In this event, additional design and development work might be needed to demonstrate the applicability of remote technologies for the SDA waste conditions. (Note that significant improvements are being made to remotely operated excavation equipment by commercial vendors.) Work would be focused on retrieving, sizing, and sorting technologies and developing remote system designs that would achieve acceptable production rates.

4.6.2.11 Cost (Balancing Criterion). The net present value of the RTD alternative is estimated at $3,780 million, which includes capital costs of $3,776 million and O&M costs of $3 million. Table 4-18 summarizes costs for the RTD alternative.

The primary capital costs are associated with waste retrieval and treatment applications at primary waste sites. The primary O&M costs are associated with the environmental monitoring program. Costs include an estimated average 40% contingency. Factors that are addressed with assumptions in PERA cost estimates include the following:

- Production rate
- Remote versus manned equipment
- Characterization requirements at digface, treatment facility, and for disposal
- Hazard classification (Category 1, 2, 3, or radiological)
- Treatment requirements for disposal
- Availability of disposal capacity at WIPP
- Characterization costs for WIPP disposal
- Number of unknown conditions that could cause shutdown or redesign.

Table 4-18. Total estimated costs for the Retrieval, Treatment and Disposal alternative with contingency.

Cost Element	Total Costs ($M)	Net Present Value ($M)
Capital costs		
Waste and soil RTD	5,771.0	—
In situ grouting treatment	191.7	—
Surface barrier	83.6	—
Volatile organic compound treatment using ISTD	52.2	—
Testing	133.2	—
Management, design, and reporting	627.2	—
Total capital costs	6,858.9	3,776.4
Operating and maintenance		
Monitoring and surveillance	16.7	—
Cover maintenance	9.0	—
Fencing and signage	0.3	—
Management	4.2	—
Total operating and maintenance costs	30.2	3.4
Total	**6,889.1**	**3,779.7**

ISTD = in situ thermal desorption
RTD = retrieval, treatment, and disposal

One of the most sensitive elements in the cost estimate is the operational production rate for retrieval. As discussed previously, a retrieval rate of 76 m^3 (100 yd^3) per shift was used to estimate the overall retrieval schedule. However, because of the complex nature of the waste stream, project delays, or slower actual production, risks could be realized. In addition, if the decision were made to remotely retrieve the waste using a robotic versus the operator-in-cab method, then the production rate would be greatly affected (e.g., possibly decreased by a factor of two [Sykes 2002]).

A cost evaluation has been performed to show the sensitivity of the total capital costs for the RTD alternative when production rates are varied. Figure 4-28 shows the projected cost increase if the waste retrieval rate was decreased from 100 yd^3 per day. As shown, if retrieval production rates slowed from 76 m^3 (100 yd^3) per day to 38 m^3 (50 yd^3) per day, the total capital costs would increase from approximately $6.9 to $8.9 billion.

Costs for waste transportation and disposal at WIPP are not included in the cost estimate. These costs are covered by other DOE budgets.

Past retrieval actions at other DOE complexes have run into unknown conditions and have shut down, reevaluated the situation, redesigned the alternative, and may (or may not) have commenced remediation (Sykes 2002). This type of situation could possibly occur at the SDA, and such an occurrence could greatly increase the cost of this alternative. For this PERA, it is assumed that these costs would be included in the established contingency budget.

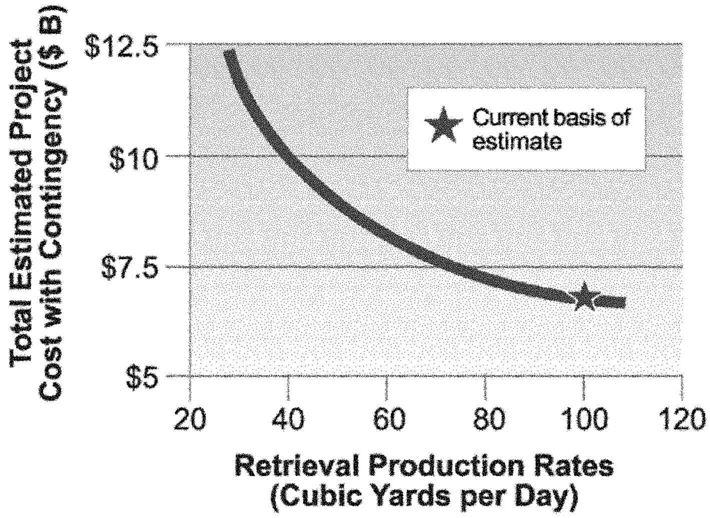

Figure 4-28. Sensitivity analysis for Retrieval, Treatment, and Disposal alternative production rates and total projected costs.

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